WORLD BOOK

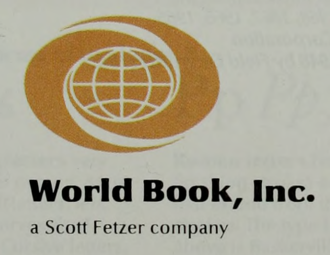
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P Volume 15

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Pp

P is the 16th letter of our alphabet. It was also a letter in the alphabet used by the Semites, who once lived in Syria and Palestine. They named it *pe,* their word for *mouth,* and adapted an Egyptian *hieroglyphic* (picture symbol) meaning *mouth* to represent it. The ancient Greeks took the letter for their alphabet and called it *pi.* When the Romans adopted the Greek alphabet, they developed the letter form that we use today. See **Alphabet.**

Uses. *P* or *p* is about the 18th most frequently used letter in books, newspapers, and other printed material in English. In chemistry, *P* stands for *phosphorus. P* is used as an abbreviation for *post,* as in *P.S.* for *postscript.* Post comes from the Latin word for *after,* and we also use it in *p.m.,* or *post meridiem,* for afternoon. In bibliographies, *p* stands for *page;* in money, *p* stands for *penny* and for *peso,* a unit of currency in Spanish-speaking countries. In grammar, *p* represents *past* and *participle.* In music, it stands for *piano,* an Italian word that means *softly.*

Pronunciation. In English, a person pronounces *p* by closing the lips and the velum, or soft palate, and temporarily stopping the breath passage. The vocal cords are apart, and do not vibrate. The typical sound of *p* occurs in such words as *pie* and *pen.* The combination *ph* is often sounded as *f* in such words as *physics* and *photograph. P* is silent in such words as *pneumonia* and *raspberry.* The letter has always had much the same sound. See **Pronunciation.** Marianne Cooley

Development of the letter P



The ancient Egyptians used this symbol for *mouth* about 3000 B.C.



The Semites, about 1500 B.C., adapted the Egyptian symbol. They used it for the letter *pe,* their word for *mouth.*

The Phoenicians used a rounded, hook-shaped letter about 1000 B.C.

The Greeks squared the hook and added it to their alphabet about 600 B.C. They named the letter *pi.*

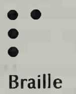
The Romans gave the P its present shape about A.D. 114.

The small letter p appeared during the A.D. 600's. By about 1500, the letter had developed its present form.

A.D. 600 — Today

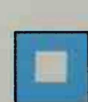
Special ways of expressing the letter P

International Morse Code

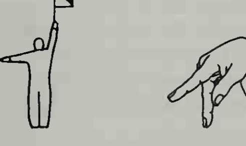


Braille

International Flag Code



Semaphore Code



Sign Language Alphabet

Common forms of the letter P

Pp *Pp*

Handwritten letters vary from person to person. *Manuscript* (printed) letters, *left,* have simple curves and straight lines. Cursive letters, *right,* have flowing lines.

Pp *Pp*

Roman letters have small finishing strokes called *serifs* that extend from the main strokes. The type face shown above is Baskerville. The italic form appears at the right.

Pp *Pp*

Sans-serif letters are also called *gothic letters.* They have no serifs. The type face shown above is called Futura. The italic form of Futura appears at the right.

P

Computer letters have special shapes. Computers can "read" these letters either optically or by means of the magnetic ink with which the letters may be printed.

PAC. See Political action committee.

Paca, *PAH kuh* or *PAK uh,* is a large rodent found in the tropics of North and South America. Pacas measure 24 ½ to 32 ½ inches (62 to 83 centimeters) long. Most pacas weigh 14 to 22 pounds (6.3 to 10 kilograms).

Pacas have a small, thick head; stout body; short, slender legs; and short tail. There are five long toes on each back foot and four on each front foot. Pacas are covered with rough, brownish or black hair. Four rows of white spots line each side of their body. Pacas have unusually large cheek pouches. The pouches form roomy chambers that help the animal make sounds.

Pacas are found from central Mexico south to Paraguay, and in the Andes Mountains of Venezuela, Colombia, and Ecuador. They live in forests, usually near rivers. Pacas are good swimmers and often escape from enemies by water. Most pacas live alone in burrows, caves, woodpiles, stumps, or rocks. Most females produce two litters a year of one or two young.



WORLD BOOK illustration by John F. Eggert

The paca is a large rodent that lives in forests.

Pacas come out for food only at night. They eat plants, roots, seeds, and tropical fruit. Pacas also sometimes eat such crops as sugar cane, corn, and yams, and are often hunted in areas where these crops grow. Hunters also kill pacas for their tasty flesh, which is eaten. Wild dogs and ocelots also prey on pacas. Charles A. Long

Scientific classification. Pacas belong to the family Agoutidae. The scientific names for the two most common species are *Agouti paca* and *A. taczanowski.*

Paca, *PAY kuh,* **William** (1740-1799), a Maryland signer of the Declaration of Independence, took part in many American political movements from 1771 until his death. He served in the Continental Congress from 1774 to 1779, and was governor of Maryland from 1782 to 1785. President George Washington appointed him judge of the Court for Maryland in 1789, a post he held until his death.

Paca was born on Oct. 31, 1740, near Abingdon, Maryland. He attended what is now the University of Pennsylvania and studied law at Annapolis, Maryland, and in London. Gary D. Hermalyn

Pacemaker. See **Defibrillator;** **Heart** (Abnormal heart rhythms); **Medicine** (picture: A pacemaker).

Pachomius, *puh KOH mee uhs,* **Saint** (290?-346), a Christian monk from Egypt, founded the first Christian religious communities called *monasteries.* He organized the first monastery in 320. He eventually established nine monasteries for men as well as two for women.

Pachomius's monasteries were groups of connected buildings walled off from the outside world where monks and nuns lived under militarylike discipline. Pachomius emphasized manual labor, ascetic practices, common prayer, and strict obedience to the monastery's leaders. In addition, he developed regulations, called a *rule,* to meet the economic and spiritual needs of his monastic communities. Pachomius's rule became the model for all later monastic rules, notably those prepared by Saint Basil and Saint Benedict. In 404, Saint Jerome translated Pachomius's rule into Latin. In this form, it significantly influenced the development of monasticism in the West.

Pachomius was born near Isna, Egypt. He converted to Christianity about 313 and became a hermit. His feast day is May 14. Richard R. Ring

See also **Monasticism** (Christian monasticism); **Religious life** (Religious life in early Christianity).

Pachycephalosaurus, *PAK uh SEHF uh luh SAWR uhs,* was a plant-eating dinosaur that had a remarkably thick skull. The name *Pachycephalosaurus* comes from Greek words meaning *thick, head,* and *lizard.*

Pachycephalosaurus possessed a bulky body with short forelimbs and long legs. It probably weighed over 1 ton (0.9 metric ton) and measured 13 to 26 feet (4 to 8 meters) in length. The dinosaur most likely traveled on its hind legs. When moving, *Pachycephalosaurus* may have carried its body parallel to the ground. A network of bony tendons held aloft its heavy, rigid tail.

Pachycephalosaurus's thick head was domed over the braincase. The top of its skull measured up to 10 inches (4 centimeters) thick, and bony knobs covered portions of the skull. The animal may have used its thick dome in butting contests for mates or territory. *Pachycephalosaurus* also had a narrow snout topped by short spikes, possibly for digging up vegetation. Its small, ridged teeth were not strong, and the animal probably ate fruits, leaves, and seeds. A keen sense of smell and large eyes helped it detect approaching predators.

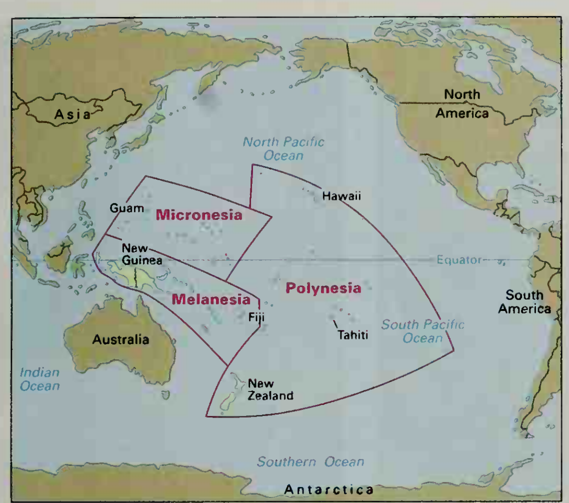
Pachycephalosaurus lived about 68 million to 65 million years ago, during the last part of the Cretaceous Period. Scientists have found the dinosaur's remains in western North America. David B. Weishampel

Pachyderm, *PAK uh durm,* is one of the *pachydermata,* a zoological classification that has been abandoned. This group included such noncud-chewing, hoofed mammals as the elephant and rhinoceros. See also **Elephant** (Skin and hair). Hugh H. Genoways

Pacific Coast States are California, Oregon, and Washington. See **United States** (Regions). See also the articles on the states that make up the region.

Pacific Islands, also called Oceania, is the name given to a group of many thousands of islands scattered across the Pacific Ocean. No one knows exactly how many islands are in the Pacific. Geographers estimate that there are from 20,000 to more than 30,000. Some islands cover thousands of square miles or square kilometers. But others are no more than tiny piles of rock or sand that barely rise above the water.

Some islands in the Pacific do not belong to Oceania. Islands near the mainland of Asia, such as those that make up the nations of Indonesia, Japan, and the Philippines, are considered part of Asia. Islands near North America and South America, such as the Aleutians and the Galapagos, are grouped with those continents. Australia is itself a continent and so is not considered part



WORLD BOOK map

The Pacific Islands can be divided into three main areas: (1) Melanesia, meaning *black islands;* (2) Micronesia, meaning *small islands;* and (3) Polynesia, meaning *many islands.*

of Oceania. These areas are part of what is called the Pacific Rim.

Although some islands of Oceania are large, all of them together cover less land than does the state of Alaska. New Guinea is the largest island in the group and the second largest island in the world, after Greenland. New Zealand's two main islands are the second and third largest islands in Oceania. Together with New Guinea, they make up more than four-fifths of the total land area of the Pacific Islands.

Oceania can be divided into three main areas: (1) Melanesia, (2) Micronesia, and (3) Polynesia. These areas are based on the geography of the islands and on the culture and ethnic background of the native peoples.

Melanesia means *black islands.* Its name is derived from the word *melanin,* which is the blackish or brownish pigment produced in the skin. The Melanesian people have large amounts of melanin in their skin, which makes their skin very dark. Melanesia includes New Guinea, the Solomon Islands, New Caledonia, and Vanuatu. Fiji is considered part of Melanesia because of its location. But its culture is much more like that of Polynesia. The Melanesian islands lie south of the equator.

Micronesia means *tiny islands.* These islands lie north of Melanesia, and most of them also lie north of the equator. More than 2,000 islands make up Micronesia. Most of them are low-lying coral islands. Micronesia includes Guam, the Caroline Islands, the Mariana Islands, the Marshall Islands, the Gilbert Islands, and the single island of Nauru.

Polynesia means *many islands.* It occupies the largest area in the South Pacific. There are long distances between its island groups. Polynesia stretches from Midway Island in the north to New Zealand, 5,000 miles (8,000 kilometers) to the south. The easternmost island in Polynesia, Easter Island, lies more than 4,000 miles (6,400 kilometers) east of New Zealand.

The land and climate differ greatly throughout the Pacific Islands. Many of the islands, especially those in Polynesia, are famous for their sparkling white beaches, gentle ocean breezes, and swaying palm trees. Some other islands, especially in Melanesia, have thick jungles and tall mountain peaks. Many lowland areas in these islands are steaming hot, but the tallest mountain peaks are covered with snow throughout the year.

About 15 million people live in the Pacific Islands. Only a few islands or island groups, such as Fiji, Hawaii, New Guinea, and New Zealand, have large numbers of people. Many islands have fewer than a hundred people, and others have none at all.

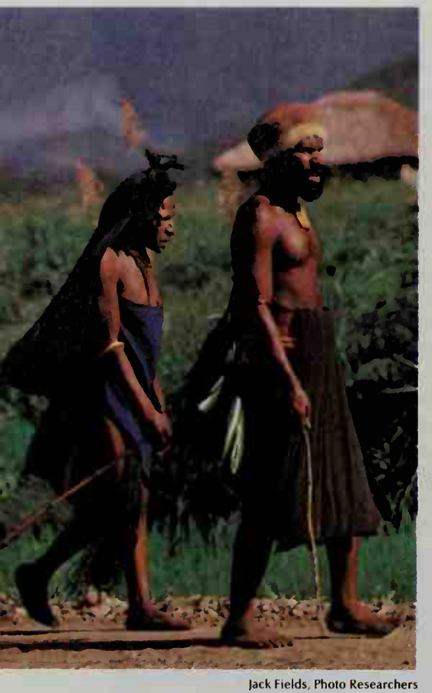
The first Pacific islanders came from Southeast Asia several thousand years ago. Their earliest settlements were in Melanesia and Micronesia. Most of Polynesia was settled later.

Over a period of thousands of years, a variety of cultures developed in the Pacific Islands. This variety resulted in part from the varied environments on the different islands. However, most of the islanders traditionally lived in villages and fished or farmed. They knew nothing of what went on in the rest of the world, and the rest of the world knew nothing of the islands. Then in the 1500's, the first Europeans arrived in the Pacific. By the late 1800's, several European countries and the United States had taken control of most of Oceania.

David Moore, Black Star



The spectacular scenery of the Pacific Islands attracts many tourists. The cable car in the foreground carries visitors on a breathtaking ride across Pago Pago Bay in American Samoa.



Jack Fields, Photo Researchers



Jack Fields, Photo Researchers



David Moore, Black Star

Population groups. Some scientists divide the people of the Pacific Islands into three population groups—Melanesian, Micronesian, and Polynesian. Melanesians, shown in the photograph at the left, have the darkest skin. Micronesians, *center,* have a somewhat lighter skin. Polynesians, *right,* are the tallest and lightest skinned.

Americans and Europeans brought their own ways of life to the islands. As a result, the islands have two ways of life today. There is the new way, brought by Americans and Europeans, and the old way, handed down for hundreds or thousands of years. Many islands now have busy, rapidly growing towns and cities much like those in North America and Europe. But most people still live in villages, and many of them follow the same way of life their ancestors did.

New Zealand and Hawaii differ from the rest of Oceania in many ways. New Zealand is an independent, highly developed nation and has a modern economy. Most of its people have a European background. Hawaii is a state of the United States and, like New Zealand, has a modern economy (see **Hawaii; New Zealand**).

This article deals mainly with the other islands of the Pacific. At one time, most of them were ruled by other countries. But many of the people on these islands felt that the ruling countries had taken much more from the islands than they had given in return. Beginning in the early 1960's, a growing number of islanders demanded the freedom to govern themselves. As a result, today most islands or island groups are independent or have some form of self-government.

People

The first settlers in the Pacific Islands probably came from Southeast Asia thousands of years ago. They reached the islands by means of rafts or dugouts and followed land bridges whenever possible. Over many centuries, most of the islands of the Pacific became settled. But large expanses of ocean separated the people in one part of the Pacific from those in another. As a result, people in distant island groups had little or no contact with one another.

During the 1700's and 1800's, European explorers visited most of the Pacific Islands. They noted that people in Melanesia, Micronesia, and Polynesia differed from one another in appearance. The islanders also had different languages, religions, and customs.

Some scientists divide the people of the Pacific Islands into three main groups—Melanesian, Micronesian, and Polynesian. However, other scientists suggest only two basic divisions of the islanders—Melanesian and Micronesian/Polynesian.

The population groups are not clearly divided among the three geographic and cultural areas of the Pacific Islands. For example, groups of people with Polynesian features live in parts of New Guinea, which is deep in Melanesia. Furthermore, people from each of the areas have migrated to the other regions. Asians and Europeans have also migrated to the islands and married islanders. Their children have mixed physical features. Nevertheless, there are still noticeable physical differences among the people in the three areas.

Melanesians are the shortest of the peoples of the Pacific Islands. Many resemble black Africans. In addition to their dark skin, most have black, woolly hair. Some Melanesians, called *Negritos,* are like the Pygmies (see **Negritos; Pygmies**).

Micronesians are somewhat taller and have somewhat lighter skin than the Melanesians. Most Micronesians have wavy or woolly hair. Those who live closest to Asia have certain Asian characteristics, such as high

cheekbones and straight hair. The people of the Yap Islands and some of the people of the Palau Islands are quite dark and look like the Melanesians.

Polynesians are the tallest and have the lightest skin of the Pacific peoples. They have straight to wavy hair. Some Polynesians—especially those of the island groups of Samoa, Tonga, and Hawaii—are robust, large-boned people. Marriages between islanders and Asian or European settlers have been more common in Polynesia than in the other two culture areas. As a result, many Polynesians have mixed Asian, European, and Polynesian physical traits.

Other peoples make up only a small part of the total population of the Pacific Islands. Only Hawaii and New Zealand have a majority of people who are not native to the islands. Hawaii has many American and Japanese settlers. Most New Zealanders are descendants of British settlers.

Smaller groups of Asians and Europeans live in other parts of the Pacific Islands. More than a third of the people of New Caledonia are of European or part European descent. Tahiti and some other islands in French Polynesia have a number of French and Chinese settlers. Smaller numbers of Europeans and Chinese live in Fiji and New Guinea. Wherever they have settled, Americans, Asians, and Europeans have had great influence on the lives of the islanders. Some island leaders feel that these outside influences have been too great and that the islanders have given up too many of their own traditions and customs.

Languages. About 1,200 of the world's 3,000 languages are spoken in the Pacific Islands. Melanesia has the greatest number of languages. More than 740 languages are spoken in Papua New Guinea alone. Micronesia has about 13 major languages. Polynesia has about 20 languages, all of which are closely related.

English is the most widely used language in the Pacific Islands. It is the official language of Hawaii and of several independent nations, including Fiji, New Zealand, Samoa, and Tonga. English is also the official language of island territories controlled by Australia, Britain, New Zealand, and the United States. But many of the people of these territories speak only their island language.

Some people who live on islands of western Micronesia speak Japanese, which they learned when Japan controlled the islands from 1920 to 1945. French is the official language of the territories controlled by France, but the islanders also speak their own languages.

A language called *Pidgin English* or *Neo-Melanesian* has developed on all the main islands of Melanesia except Fiji and New Caledonia. Pidgin English consists mainly of words from English and the island languages. This language gives the people of Melanesia, who speak many languages, a means of communicating with one another.

Religions. Christianity has been the main religion in Oceania since the late 1800's. Before then, the islands had a number of religions, all based on a belief in numerous gods or spirits. Most religions had a complicated mythology made up of stories about the creation of the earth and the relationships between the gods and people (see **Mythology** [Mythology of the Pacific Islands]).

Today, island religions survive mainly in Melanesia, particularly in New Guinea, the Solomon Islands, and Vanuatu. But even in areas where most of the people are Christians, many of the islanders still believe in magic and witchcraft.

A kind of religion called a *cargo cult* exists in parts of Melanesia. Members of a cargo cult believe that the gods intend them to have a share of the goods that Westerners enjoy. The cargo cult's leaders promise that one day a giant cargo ship or plane will arrive containing the islanders' share of Western goods.

In a few parts of the Pacific Islands, the people once practiced *cannibalism* (the eating of human flesh). Some people considered it a religious ceremony. They believed that by eating a dead person's flesh, they took on that person's good qualities. Cannibalism no longer exists in the Pacific Islands except in New Guinea, where it occasionally occurs.

Ways of life

Most Pacific islanders live in small farming or fishing villages. Many of them live in the same kinds of houses, eat the same kinds of food, and wear the same kinds of clothing their ancestors did. But these traditional ways of life are changing rapidly as more and more people adopt the customs of Western countries.

Villages. Many Pacific islanders have left their villages to work in the towns and cities, but the village remains the basic community of the islands. The smallest villages have only a few people, and the largest have several hundred. All the families of a village feel strong ties to one another even though they may not be related. Such *kinship groups* play an important part in the lives of most Pacific islanders. In Polynesia, the people of some entire islands and groups of islands feel bound by ties of kinship.

In most villages, each family has its own house or cluster of houses. A household may include grandparents, aunts, uncles, and cousins. Most houses have a wooden framework, with walls and roof made of thatch. They have a round, oval, square, or oblong shape. In the hot coastal areas of New Guinea, many people build their homes on stilts, which makes the houses cooler and protects them from moisture on the ground. In the cool highlands of New Guinea, most of the houses are low and circular, with tightly fitted walls of wood and thatch to help conserve heat on chilly nights.

Chiefs play an important part in the affairs of many villages. A village chief is expected to advise and lead the people, show hospitality to visitors, and uphold the good name of the community. On most Pacific Islands, the chief inherits the office. In Polynesia and on Fiji, the office of chief passes from father to son. In most parts of Micronesia, a chief is succeeded by the oldest son of the chief's oldest sister. In Melanesia, a village chief earns the office by achievement rather than by birth.

Towns and cities. Oceania has few towns and cities, but they are growing rapidly. Hawaii and New Zealand have the only large cities in the islands. The largest city outside Hawaii and New Zealand is Port Moresby, Papua New Guinea. Other small cities or large towns include Apia in Samoa, Noumea in New Caledonia, Papeete in French Polynesia, and Suva in Fiji. Most towns and cities in Oceania have an elected governing body.



Emil Muench from Carl Östman

Traditional ways of life are followed by many Pacific Islanders, especially villagers who earn little or no money. At this village market in New Guinea, many of the people trade one kind of farm product for another, just as their ancestors did.

Houses in Pacific Island towns and cities look much like those in Western countries and are made of such materials as wood, concrete block, and brick. The rapid growth of towns and cities has created a housing shortage in some areas. As a result, shantytowns have sprung up on the outskirts of the fastest-growing towns. Some island governments have started programs to build modern, inexpensive houses.

Food. Traditionally, the people of the Pacific Islands have depended largely on fish and native plants for food. In shallow water, people catch crabs, lobsters, shrimps, and turtles. Farther out at sea, they catch bonito and tuna. On many islands, the people eat the fruit of breadfruit and pandanus trees and the meat of coconuts from the coconut palm. The people of New Guinea make flour from the starchy *pith* (soft center) of the sago palm. They use the flour to make small cakes and biscuits. Many islanders have vegetable gardens in which they grow sweet potatoes and *taro,* a plant with a starchy underground stem. Many people also raise bananas and some plants introduced from other parts of the world, such as corn, pineapples, rice, and tomatoes. Some farmers also have chickens and pigs.

Many islanders cook their food in ground ovens. A common type of ground oven consists of a shallow pit lined with heated stones. The food is placed on the stones and covered with a layer of leaves. The pit is then filled with earth to hold in the heat.

Although many islanders still eat the traditional foods, canned foods from Western countries have become so popular on some islands that many people eat almost nothing else. As a result, malnutrition is a problem in many cities and towns. Local health agencies try to persuade the people to balance their diets with fresh fruits, vegetables, and meats.

Clothing. Many people in the Pacific Islands, especially in the towns and cities, wear Western-style clothing. But some villagers wear traditional dress. In Polynesia and Fiji, the men often wear a cloth skirt called a *lava-lava* or *sulu.* Some women in Fiji, Hawaii, and the Samoa Islands wear long, loose-fitting cotton garments called *muumuus.* In Fiji, the Samoa Islands, and Tonga, women also make skirts of *tapa cloth.* They make tapa cloth by stripping the inner bark from paper mulberry trees, soaking it, and then beating it with wooden clubs. On a number of islands—especially the Gilbert Islands, New Guinea, and the Solomon Islands—both men and women sometimes wear grass skirts. A few mountain tribes in New Guinea, the Solomons, and Vanuatu wear only brief coverings of bark or leaves around their waists. In the cool New Guinea highlands, some of the people keep warm by greasing their naked bodies with pig fat.

Arts and crafts. Many islanders, especially in the villages, are skilled artists and craftworkers. On some islands, the people use the leaves and fibers of native plants, such as palm and pandanus trees, to weave baskets and mats, which they decorate with colorful designs. Some islanders use native woods to carve masks, cooking utensils, and other objects. On a few islands, people make pottery. The islanders sell some of their handicrafts to tourists and export companies. See **Sculpture** (Pacific Islands sculpture) for a description and pictures of the colorful sculpture of the Pacific area.

Recreation. On most islands of the Pacific, the villagers gather for traditional feasting, dancing, and singing on such occasions as births and marriages. Dancing is a major part of village festivities. The dancers often wear masks, feathers, flowers, sea shells, or other colorful ornaments. Polynesian dancing is especially lively. The Tahitian *tamure* and the Hawaiian *hula* are popular Polynesian dances. On some Polynesian islands and on



London Daily Telegraph from Woodfin Camp, Inc.

Ceremonial dances are a colorful tradition of the islands. These New Guinea dancers are taking part in a ceremony called a *sing-sing.*



Jack Fields, Photo Researchers

New ways of life have come mainly from the West. These Fiji islanders are playing rugby football, a British game. Many Pacific islanders—especially in the towns and cities—have given up their native customs and adopted Western ways.

Fiji, important festivals include the ceremonial drinking of *kava,* a drink made from the roots of the native kava plant. Many islanders enjoy playing games introduced from Western countries, such as volleyball and rugby football.

Education. All the populated islands of Oceania have elementary schools, and many also have high schools. Christian missionaries started the first schools in the Pacific and continue to operate many of them today. Most islands could not afford to run schools without the missionaries' help. But some island governments are able to assist the mission schools financially.

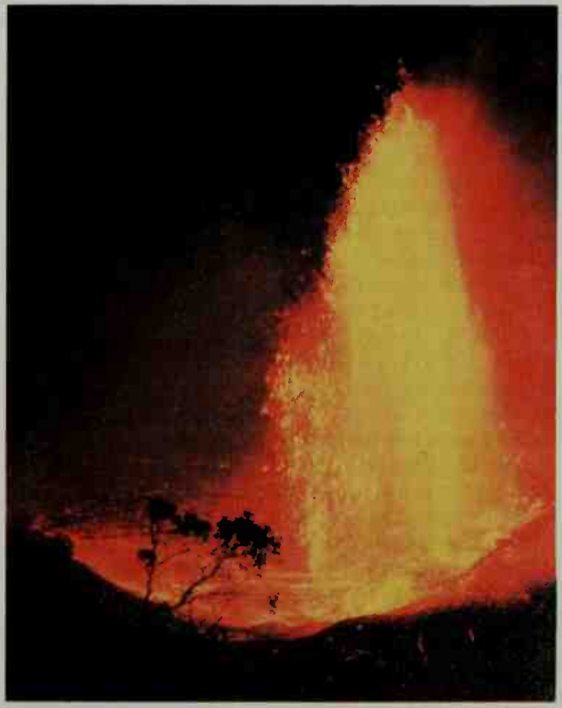
Many island children do not continue their education beyond elementary school. Relatively few young people finish high school and go on to colleges or universities. Hawaii and New Zealand have the only large universities in the Pacific Islands. Smaller universities are located in Fiji, Guam, and Papua New Guinea. Some islands have small colleges that specialize in agriculture, medicine, or theology.

The land and climate

The islands of the Pacific can be divided into two main types: (1) high islands and (2) low islands.

The high islands are made up largely of hills and rugged mountains. Some of the mountains rise high above sea level, and many are active volcanoes. The high islands also have frequent, sometimes severe, earthquakes. The largest islands of the Pacific—New Britain, New Caledonia, New Guinea, and New Zealand—are high islands. The high islands also include the main islands of such groups as Fiji, Hawaii, the Marianas, Samoa, the Solomons, and Vanuatu.

The low islands consist of *coral reefs,* which are formed by the skeletons of millions of tiny sea animals (see **Coral**). Thousands of these islands are scattered throughout the Pacific. Most of them are smaller than the high islands and rise only a few feet or a meter above sea level. Earthquakes in the Pacific sometimes create large, destructive ocean waves called *tsunamis*



Robert Goodman, Black Star

Kilauea, on the island of Hawaii, is one of the most spectacular volcanoes in the Pacific Islands. On the same island is Mauna Loa, the world's largest volcano.



David Moore, Black Star

Two main types of islands are found in the Pacific. *High islands* are mountainous and volcanic. *Low,* or *coral, islands* are formed by skeletons of tiny sea animals. The island in the background—Bora Bora—is a high island surrounded by small coral islands like the one in the foreground.

that flood the lowest of these islands.

The majority of the low islands are *atolls.* An atoll is a coral reef—or a number of small reefs called *motus*—surrounding a large lagoon. The low islands include all the islands in the Gilbert, Marshall, Phoenix, Tuamotu, and Tuvalu groups, as well as many individual islands in other groups. Movements within the earth have lifted some atolls higher than others. Such *raised atolls* include Nauru and Niue. Coral reefs or atolls also lie off the shores of most high islands.

Climate. Almost all the islands of the Pacific lie in the tropics and so are warm the year around. On most islands, the temperature seldom falls below 70 °F (21 °C) or rises above 80 °F (27 °C). But mountain areas in New Guinea and a few other high islands are somewhat cooler. The tallest mountains in New Guinea and New Zealand are snow covered the year around.

Rainfall varies greatly throughout Oceania. Some islands, especially the low islands, may have only a few inches or centimeters of rain a year. Other islands, especially the Carolines and the high islands in western Melanesia, often have more than 150 inches (381 centimeters) a year. Most islands have a wet season and a dry season. In Melanesia and Polynesia, the wet season lasts from December to March and the dry season from April to November. In Micronesia, the wet season lasts from May to December and the dry season from January to April.

Typhoons often strike islands in the Pacific. They bring violent winds and heavy rains, which sometimes cause great loss of life and enormous property damage. In Micronesia, typhoons may strike at any time, but they occur most frequently from July to October. Most South Pacific typhoons occur from January to March.

Economy

Hawaii, New Zealand, and Nauru have well-developed economies. Hawaii's economy is based largely on U.S. government employment and on tourism. New Zealand has thriving agricultural and manufacturing industries. On these islands, most workers are wage earners. The people of Nauru receive most of their income from mining operations. But on the other Pacific Islands, many people earn little or no money. Most of them are villagers who raise their own food, build their own houses, and make their own clothing. They may earn a small income by raising coconuts, bananas, or sugar cane to sell to export companies. Throughout the Pacific Islands, a growing number of villagers are moving to the towns and cities to work for wages.

Natural resources. On many of the low islands, the soil is too poor and the rainfall too light for plants to grow well. Only grass and small shrubs grow on these islands. Low islands with heavier rainfall have coconut palms and pandanus trees. Many of the high islands have fairly fertile soil and plentiful rainfall. Unusual flow-

ers and trees grow on these islands. New Guinea, the Solomon Islands, and Vanuatu are covered with thick jungles and steaming forests.

The islands' few native animals include birds, land crabs, lizards, and rats. Albatrosses, terns, and other birds are the most common animals. New Guinea and a few of the nearby islands have crocodiles and snakes. These islands also have kangaroos and other *marsupials* (mammals that give birth to extremely undeveloped young).

The islands have few mineral resources, except for valuable deposits of nickel on the island of New Caledonia and copper, gold, and oil on the island of New Guinea. New Caledonia also has some chromium and iron, and Fiji has small deposits of gold and manganese. Nauru has deposits of phosphate, which is used to make fertilizer.

Agriculture is the main industry of Oceania, and *copra* (the dried meat of the coconut) is the most important agricultural product. Factories crush copra to produce coconut oil, which is used to make such products as margarine and soap. Many countries import coconut oil or copra from the Pacific Islands. Tonga, Samoa, Fiji, and the Cook Islands also grow bananas for export. The production and export of sugar is the main industry in Fiji. New Guinea farmers grow cocoa and coffee for sale overseas.

At one time, Europeans owned much of the farmland in the Pacific Islands. Today, many islanders have their own farms. In some villages, the farmland belongs to the entire community.

Mining and manufacturing. Many of the islands are trying to develop other industries in addition to agriculture. Islands with mineral deposits, such as Fiji and New Caledonia, are expanding their mining industries. Phosphate mining is important on Nauru, but phosphate deposits are being used up rapidly.

In larger towns of the Pacific Islands, mills and factories produce such goods as coconut oil, soap, and sugar. The Solomon Islands, Papua New Guinea, Samoa, and some other forested islands use sawmills to process native timbers.

Independent countries of Oceania*

Name	Area In mi²	Area In km²	Population	Capital	Official language	Date of independence
Fiji	7,056	18,274	840,000	Suva	English	1970
Kiribati	280	726	85,000	Tarawa	English	1979
Marshall Islands	70	181	68,000	Majuro	Marshallese; English	1986
Micronesia, Federated States of	271	702	124,000	Palikir	English	1986
Nauru	8	21	12,000	—	Nauruan	1968
New Zealand	104,454	270,534	3,930,000	Wellington	English; Maori	1907
Palau	177	459	20,000	Koror	English; Palauan in 13 of Palau's 16 states; local languages in other 3 states	1994
Papua New Guinea	178,704	462,840	5,015,000	Port Moresby	Melanesian pidgin English; Motu	1975
Samoa	1,093	2,831	187,000	Apia	Samoan; English	1962
Solomon Islands	11,157	28,896	470,000	Honiara	English	1978
Tonga	288	747	100,000	Nuku'alofa	English; Tongan	1970
Tuvalu	10	26	13,000	Funafuti	Tuvaluan; English	1978
Vanuatu	4,706	12,189	199,000	Port-Vila	Bislama; English; French	1980

*Each country listed has a separate article in *World Book*.

Other political units in Oceania

Name	Area In mi²	Area In km²	Population	Status
American Samoa†	77	199	73,000	U.S. territory
Cook Islands†	93	240	20,000	Self-governing area in free association with New Zealand
Easter Island†	47	122	2,000	Chilean dependency
French Polynesia†	1,540	4,000	243,000	French overseas territory
Guam†	209	541	173,000	U.S. territory
Hawaii†	6,459	16,729	1,234,000	U.S. state
Irian Jaya	162,879	421,855	2,173,000	Indonesian province
Midway Island†	2	5	450	U.S. possession
New Caledonia†	7,366	19,079	221,000	French overseas country
Niue	100	260	2,000	Self-governing area in free association with New Zealand
Norfolk Island†	14	36	2,000	Australian territory
Northern Mariana Islands, Commonwealth of the†	184	477	87,000	U.S. commonwealth
Pitcairn Islands Group†	17	44	54	British overseas territory
Tokelau	4	10	2,000	New Zealand territory
Wake Island†	3	8	300	U.S. possession
Wallis and Futuna Islands	106	275	15,000	French overseas territory

Populations are 2002 estimates for countries and 2002 and earlier estimates for other political units based on figures from official government and United Nations sources.
†Has a separate article in *World Book*.

1 2 3 4 5 6 7

A B C D E F G H

30° North Latitude
Okinawa
Naha
Ryukyu Islands (Japan)
Tropic of Cancer
Philippine Sea
PHILIPPINES
Samar
Leyte
Mindanao
Davao
Farallon de Pajaros
Agrihan
Pagan
Anatahan
Saipan
Rota
Tinian
Northern Mariana Islands (U.S.)
Guam (U.S.)
Wake Island (U.S.)
Kure
Midway Island (U.S.)
Pearl
Lisianski
Laysan
Gardner
Necker
Nihoa
Kauai
Oahu
Honolulu
Maui
Hawaii (U.S.)
Hawaii
INTERNATIONAL DATE LINE
Johnston (U.S.)
North
Taongi
Enewetak
Bikini
MARSHALL ISLANDS
Ralik Chain
Ratak Chain
Ujelang
Kwajalein
Majuro
Mili
Jaluit
Kosrae
MICRONESIA
Ulithi
Yap Is.
Namonuito
Hall Is.
Truk Is.
Senyavin Is.
Pohnpei
Mortlock Is.
PALAU
Peleliu
Pulo Anna
Tobi
Helen
Caroline Islands
FEDERATED STATES OF MICRONESIA
Morotai
Halmahera
Equator
Palmyra (U.S.)
Teraine
Tabuaeran
Kiritimati
Line Islands
Howland (U.S.)
Baker (U.S.)
Jarvis (U.S.)
Gilbert Islands
Tarawa
Banaba
NAURU
Biak
Jayapura
Papua
Bismarck Archipelago
Admiralty Is.
Bismarck Sea
New Ireland
Buka
New Britain
Bougainville
Choiseul
Santa Isabel
Malaita
SOLOMON ISLANDS
Honiara
Guadalcanal
San Cristobal
Rennell
Santa Cruz Is.
Phoenix Is.
KIRIBATI
Maldan
Starbuck
Buru
Ceram
INDONESIA
Aru Is.
New Guinea
PAPUA NEW GUINEA
Banda Sea
Dili
EAST TIMOR
Tanimbar Is.
Dolak
Trobriand Is.
Solomon Sea
Port Moresby
Woodlark
D'Entrecasteaux Is.
Louisiade Archipelago
Arafura Sea
Timor Sea
Darwin
Gulf of Carpentaria
Nanumea
Niutao
TUVALU
Vaitupu
Nukufetau
Funafuti
Nukulaelae
Atafu
Tokelau Is. (N.Z.)
Nukunono
Fakaofu
Niulakita
Uvea
SAMOA
Upolu
Savai'i
Apia
American Samoa (U.S.)
Tutuila
Rotuma
Wallis and Futuna Is. (Fr.)
Horn Is.
Penrhyn
Manihiki
Pukapuka
Vostok
Flint
Suwarrow
Cook Islands (N.Z.)
POLY
Leeward Is.
Bora Bora
Raiatea
Society
Palmarston
Aitutaki
Atiu
Mauke
Rarotonga
Mangaia
Maria
Austral
MELANESIA
Banks Is.
Espiritu Santo
VANUATU
Pentecost
Malakula
Port-Vila
Efate
Erromango
Tanna
Anatom
Vanua Levu
Viti Levu
Suva
Kadavu
FIJI
Lau Group
Ono-i-Lau
Vava'u Group
TONGA
Niue (N.Z.)
Ha'apai Group
Nuku'alofa
Tongatapu Group
Coral Sea
Great Barrier Reef
Chesterfield Is.
New Caledonia (Fr.)
Loyalty Is.
Nouméa
Tropic of Capricorn
AUSTRALIA
Fraser I.
Brisbane
L. Eyre
L. Gairdner
L. Torrens
Darling
30° South Latitude
Norfolk Island (Australia)
Kermadec Is. (N.Z.)
South Pacific
Great Australian Bight
Adelaide
Murray
Canberra
Sydney
Melbourne
Bass Strait
King I.
Flinders I.
Tasmania
Hobart
Tasman Sea
Indian Ocean
Auckland
North Island
Cook Strait
Wellington
NEW ZEALAND
South Island
Christchurch
Dunedin
Stewart I.
Chatham Is. (N.Z.)
East Longitude
180
West Longitude 150

0 1,000 2,000 3,000 4,000 5,000
0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 8,000 9,000

Pacific Islands map index



Place		
Bougainville	D	3
Enewetak	B	3
Espiritu Santo	E	4
Gardner	A	6
Guadalcanal	E	3
Hawaii	B	7
Helen	C	1
Henderson	F	9
Jaluit	C	4
Johnston	B	6
Kauai	A	7
Kure	A	5
Kwajalein	C	4
Laysan	A	6
Lisianski	A	5
Maui	B	7
Mili	C	4
Necker	A	6
Nihoa	A	6
Oahu	B	7
Pagan	B	2
Palmyra	C	7
Pentecost	E	4
Pitcairn	F	9
Rarotonga	F	6
Rota	B	2
Saipan	B	2
Tahiti	E	8
Taongi	B	4
Tinian	B	2
Tutuila	E	6
Upolu	E	6

The tourist industry in the Pacific Islands has grown tremendously since the beginning of jet airplane travel in the 1950's. As more and more tourists come to the islands, more airports, hotels, highways, shops, and restaurants will have to be built. Islands that actively encourage tourism, such as the Cook Islands, Fiji, and Tahiti, are working to construct these facilities. However, some islanders fear that further growth of the tourist industry will destroy the natural charm and traditional way of life of the Pacific. In some island groups, attempts have been made to control the development of the tourist industry.

Transportation. Canoes have long been the traditional means of transportation throughout the Pacific Islands. Villagers use them for fishing and for traveling short distances. To make longer voyages, they use canoes equipped with sails or outboard motors.

Many islanders depend on ships and airplanes for transportation. Ships of all sizes connect the major ports, and airplanes deliver food and other supplies to the islands. Fiji, New Guinea, and other islands have their own commercial airlines, which carry both passengers and cargo.

None of the islands has a well-developed highway system. But in the cities and large towns, many people own automobiles, and traffic jams occur during rush hours just as they do in cities elsewhere.

History

The first settlers. Most scholars believe the first settlers in the Pacific Islands came from Southeast Asia thousands of years ago. They probably reached the Pacific by way of Indonesia and then traveled to islands in Melanesia. They followed land bridges when possible and made parts of their journey by water, using rafts or dugouts. Some may have sailed northward to Micronesia. Over hundreds of years, settlements were set up on the main islands of Melanesia and Micronesia.

Most of the islands of Polynesia were settled later than those of Melanesia and Micronesia. Many Polynesian islands are farther apart than islands in Melanesia and Micronesia and so are harder to reach by boat. The first settlers of Polynesia were probably groups of seafaring people from eastern Melanesia or Micronesia. Some of these groups may have set out in search of new homes. Other groups may have been blown off course by violent storms. But in time, groups such as these established settlements on all the main Polynesian islands.

Discovery by Europeans. In 1513, the Spanish explorer Vasco Núñez de Balboa became the first European to sight the eastern Pacific. He saw it from Panama. In 1520, the Portuguese explorer Ferdinand Magellan began to sail westward across the Pacific. In 1521, he reached Guam. After this voyage, many Europeans searched the Pacific for other islands. The Caroline, Marquesas, Solomon, and Tuvalu island groups were visited by Europeans during this period. A Dutch explorer, Abel Janszoon Tasman, arrived in New Zealand in 1642. The greatest Pacific explorer of the 1700's was Captain James Cook of the British Royal Navy. Between 1768 and 1779, he located and accurately mapped many islands in the Pacific, including Hawaii and New Caledonia.

Missionaries, traders, and settlers. Cook's discoveries encouraged Protestants and Roman Catholics to



Jack Fields, Photo Researchers

Producing copra, the dried meat of the coconut, is a main economic activity in the Pacific Islands. This Samoan worker is removing the meat from the coconut shell before drying.

establish missions throughout Oceania. As a result, many islanders became Christians during the 1800's. Many missionaries introduced genuine improvements to the islands, but others concentrated largely on doing away with native customs and traditions. At the same time, American and European traders searched the Pacific for coconut oil, sandalwood, and other products. Ships from many countries came to hunt whales. Some traders and whalers treated the islanders badly and were badly treated in return. Slave traders called *blackbirders* took shiploads of islanders to work on plantations in Australia and South America.

European settlers also began to arrive in the islands. Wealthy Europeans started coconut, coffee, pineapple, and sugar plantations. But the new settlers also included many criminals and drifters, and lawlessness became a problem. Europeans also brought diseases against which the islanders had no resistance. On some islands, epidemics wiped out most of the population.

Colonial rule. By the late 1800's, the United Kingdom (U.K.), France, Germany, Spain, and the United States were competing to control Pacific islands. After Spain's defeat in the Spanish-American War of 1898, Germany and the United States took over Spain's possessions in Micronesia. By the early 1900's, Germany also held parts of Nauru, New Guinea, and Samoa, and the United States controlled Hawaii and the rest of the Samoa Islands. France controlled New Caledonia and French Polynesia and shared control of the New Hebrides (now Vanuatu) with the U.K. The British held Fiji, Papua, Tonga, the southern Solomons, and the Gilbert and Ellice islands. By 1910, Australia and New Zealand had won independence from the U.K. After Germany's defeat in World War I (1914-1918), Japan took control of Germany's possessions in Micronesia, New Zealand took over German Samoa, and Australia got control of northeastern New Guinea. Through all these changes of rule, the islanders had little or no voice in the government.

World War II (1939-1945). Japan increased its power in the Pacific after World War I. In December 1941, Japanese bombers attacked the U.S. naval base at Pearl Harbor, Hawaii, marking the beginning of World War II in the Pacific. By mid-1942, Japanese troops had captured islands as far east as the Gilberts and as far south as the Solomons. The United States and its allies then began the difficult job of driving the Japanese off these islands. Bloody battles were fought at Tarawa and on Guadalcanal, Iwo Jima, and other islands. In September 1945, Japan surrendered, and lost its huge Pacific empire.

Nuclear testing. After World War II, the United States began nuclear weapons tests on Bikini and Enewetak atolls in Micronesia and on Kiritimati Atoll (Christmas Island) and Johnston Island in Polynesia. The British conducted similar tests on Kiritimati Atoll. In 1963, the two countries and the Soviet Union signed a treaty banning aboveground nuclear tests. The United States and the U.K. then stopped their tests in the Pacific. France also has nuclear weapons but did not sign the test-ban treaty. From 1965 to 1996, France tested nuclear weapons in French Polynesia from time to time.

Recent developments. An organization called the Pacific Community has helped promote the islands' economic and social welfare. It was founded as the South Pacific Commission in 1947 by Australia, the United Kingdom, France, the Netherlands, New Zealand, and the United States. The Netherlands withdrew in 1962, after Indonesia took control of Dutch (West) New Guinea. Today, the organization includes most of the islands. But the newly independent nations have complained that the Pacific Community is dominated by its powerful members. As a result, the Cook Islands, Fiji, Nauru, Tonga, and Western Samoa (now Samoa) organized the South Pacific Forum in 1971 to promote cooperation among themselves in such matters as international relations and trade. Australia and New Zealand were included as Forum members due to their location and their involvement in the region's affairs. As other islands gain self-government, they have been invited to join the Forum. Forum members hope that by cooperating with one another they will depend less on Western nations.

Since 1962, some Pacific islands or island groups have become independent, and others have been working toward this goal. The British granted full independence to Fiji and Tonga in 1970 and to the southern Solomon Islands and to Tuvalu (formerly Ellice Islands) in 1978. In 1979, the United Kingdom's Gilbert Islands dependency became the independent nation of Kiribati. In 1980, the New Hebrides—which had been ruled jointly by the U.K. and France—became independent as Vanuatu.

In 1965, the Cook Islands—a territory of New Zealand—gained a form of self-government. The islands control internal affairs, and New Zealand handles external affairs as requested. Another New Zealand territory, the island of Niue, gained self-government in 1974.

After World War II, the United Nations (UN) decided that four areas in the Pacific should be governed as trust territories until they were ready for independence. New Zealand administered Western Samoa as a trust terri-

tory until 1962, when it gained independence. Western Samoa changed its name to Samoa in 1997. Australia, Britain, and New Zealand governed Nauru as a trust territory until 1968, when it became independent. The Trust Territory of New Guinea was governed by Australia until 1973, when it became part of the self-governing territory of Papua New Guinea. Papua New Guinea gained full independence in 1975.

The United States administered the Trust Territory of the Pacific Islands, which was divided into four political units. In 1986, all of the Mariana Islands except Guam became a commonwealth of the United States. Guam is a U.S. territory. Also in 1986, the Marshall Islands and the Federated States of Micronesia—comprised of all of the Caroline Islands except the Palau group—became independent nations in free association with the United States. Under free association, their governments control all of their internal and foreign affairs. However, the United States is obligated to defend the islands in emergency situations. In 1994, the Palau Islands became the independent nation of Palau. The new country also had an arrangement of free association with the United States. Robert C. Kiste

Related articles. For a list of *World Book* articles on the islands of the Pacific, see the *Related articles* at the end of the Island article. See also the following:

Atoll
Coral
Exploration
Kava
Literacy (table)
Maori
Mythology (Mythology of the Pacific Islands)
Pacific Islands, Trust Territory of the
Pacific Ocean
Sculpture (Pacific Islands sculpture)
Volcano
World War II (The war in Asia and the Pacific)

Outline

I. People
A. Melanesians
B. Micronesians
C. Polynesians
D. Other peoples
E. Languages
F. Religions

II. Ways of life
A. Villages
B. Towns and cities
C. Food
D. Clothing
E. Arts and crafts
F. Recreation
G. Education

III. The land and climate
A. The high islands
B. The low islands
C. Climate

IV. Economy
A. Natural resources
B. Agriculture
C. Mining and manufacturing
D. The tourist industry
E. Transportation

V. History

Questions

What is the main industry in the Pacific Islands?
What is another name for the Pacific Islands?
What is a *coral reef?* An *atoll?*
Where did the first Pacific Islanders come from?
What are the duties of a village chief?
Why do some islanders fear the further growth of tourism?
What is *kava?* A *muumuu?* A *cargo cult?*
What are the islanders' two main ways of life?
Who were the *blackbirders?*
What are the three main areas in Oceania?

Additional resources

Denoon, Donald, and others, eds. *The Cambridge History of the Pacific Islanders.* Cambridge, 1997.
Margolis, Susanna. *Adventuring in the Pacific: The Islands of Polynesia, Melanesia, and Micronesia Including Bora Bora, Fiji, Tahiti, Tonga, Vanuatu, and Hundreds of Others.* Rev. ed. Sierra Club, 1995.
Schellinger, Paul, ed. *International Dictionary of Historic Places, Vol. 5: Asia and Oceania.* Fitzroy Dearborn, 1996.

Pacific Islands, Trust Territory of the, was a territory administered by the United States under the approval of the United Nations (UN). The territory was established by the UN in 1947. It ceased to exist in 1994.

The trust territory originally consisted of the Caroline and Marshall islands, and all the Mariana Islands except Guam, which was already a U.S. possession. These island groups all belong to a larger area in the western Pacific Ocean called Micronesia. The islands of the territory were seized from Japan by the United States during World War II (1939-1945).

Under the terms of the trusteeship agreement with the UN, the United States assumed responsibility for the political, economic, social, and educational development of the islands. In return, the United States was recognized as the sole administering authority for the area. It was given the right to govern the territory according to its laws and to build military facilities where and when necessary. The U.S. Navy administered the Trust Territory for the United States until 1951, when administrative responsibility passed to the U.S. Department of the Interior.

Through the years, calls for self-government by the people of the territory grew. In 1969, the U.S. government and representatives from the islands began negotiations to end the trusteeship. In 1975, the Northern Marianas became a self-governing U.S. commonwealth. In 1979, four local districts in the Caroline Islands—Kosrae, Ponape (now Pohnpei), Truk (now Chuuk), and Yap—joined together and adopted a constitution to form the Federated States of Micronesia. Palau and the Marshall Islands declared themselves republics in 1979.

In 1982, Palau, the Federated States of Micronesia, and the Marshall Islands signed compacts of free association with the United States. Under these compacts, the three governments control their internal and foreign affairs. However, the United States is responsible for the defense of the islands and is obligated to provide them with financial assistance. The compacts between the United States and the Federated States of Micronesia and the Marshall Islands took effect in 1986. Palau became totally self-governing in 1994, thereby ending the Trust Territory of the Pacific Islands. David Hanlon

Related articles in *World Book* include:

Caroline Islands
Mariana Islands
Marshall Islands
Micronesia, Federated States of
Northern Mariana Islands, Commonwealth of
Pacific Islands
Palau

Pacific Northwest includes all of Oregon, Washington, and Idaho, and western Montana. The region varies greatly. Part of the Rocky Mountain system stands in the east, in Montana, Idaho, and Washington. The well-populated Willamette Valley of Oregon and the Puget Lowland of Washington are located to the west. In the middle lies the Columbia Plateau of Idaho, Oregon, and Washington. The Pacific Northwest is a major source of forest products, fruits, grain, minerals, and potatoes. Harley Johansen

Pacific Ocean is the largest body of water in the world. The ocean covers about 66 million square miles (171 million square kilometers). That area represents over 45 percent of the total area of all the oceans and about one-third of Earth's total surface area. Thousands of islands lie in the Pacific Ocean. They range from island nations, such as Japan and New Zealand, to the hundreds of small, scattered islands in the central and southern Pacific. The Pacific Ocean is a source of many natural resources, including seafood, petroleum, and minerals.

The word *pacific* means *peaceful.* The ocean received this name from the Portuguese explorer Ferdinand Magellan, who sailed its waters for several months, driven by gentle winds. But the Pacific is often far from peaceful. Typhoons and hurricanes in the Pacific have wrecked fleets of ships and destroyed island cities. Earthquakes and volcanic eruptions deep in the sea have created destructive waves called *tsunamis* (pronounced *tsoo NAH meez).* In the open ocean, those waves are hardly noticeable because of their small height. When the waves reach the shore, however, the waters can pile up to a height of more than 100 feet (30 meters).

In 1513, the Spanish explorer Vasco Núñez de Balboa crossed the Isthmus of Panama and became the first European to see the eastern Pacific. Magellan was the first European to sail across the ocean. He crossed it from November 1520 to April 1521. In the 1760's and 1770's, Captain James Cook of the British Navy explored and mapped much of the Pacific. He probably was the first European to visit the Hawaiian Islands, Australia, and New Zealand.

Boundaries. The Bering Strait between Russia and Alaska marks the northern end of the Pacific Ocean. The eastern border of the Pacific Ocean is North and South America. To the west lie the mainland of Asia and the countries Indonesia and Australia. The southern limit of the Pacific is the line of 60° south latitude. South of that line is the Southern Ocean, also known as the Antarctic Ocean.

A number of seas, called *marginal seas,* are part of the Pacific Ocean. Those include the Bering Sea, the Sea of Japan (also called the East Sea), the East China Sea, and the Tasman Sea.

The ocean floor. The depth of the Pacific Ocean varies greatly from place to place. On the ocean floor are high mountains, ridges, vast plains, and extremely deep areas called *trenches.*

One underwater mountain range, the East Pacific Rise, extends from north of Antarctica to the coast of Mexico. The height of the East Pacific Rise above the ocean floor varies from about 6,500 to 10,000 feet (2,000 to 3,000 meters). In many parts of the Pacific, volcanic eruptions have created peaks called *seamounts.* Some seamounts rise above the surface of the water, forming islands.

The deepest parts of the Pacific Ocean are in the trenches. Most of the trenches are from 20,000 to 30,000 feet (6,000 to 9,000 meters) deep. The Mariana Trench, near Guam, includes the Challenger Deep, the deepest known spot in any ocean. The Challenger Deep extends 35,840 feet (10,924 meters) below the water's surface.

Chimneylike structures called *hot vents,* or *hydrothermal vents,* lie mainly in the eastern Pacific. Those structures occur as a result of ocean water seeping down through cracks in the ocean bottom. Underlying rock heats the water, which then rises back to the ocean floor to create mineral-rich springs. See **Hot vent.**

A shallow region of ocean floor called a *continental shelf* extends off the shore of each continent bordering the Pacific. The water on the continental shelves is usually less than 660 feet (200 meters) deep.

Climate. The North Pacific has long, cold winters and short, cool summers. Along the equator, the climate is hot all year. In much of the South Pacific, summers are mild, and winters are cool. In the southernmost part of the Pacific, winters are cold and stormy.

Winds over the Pacific include the *trade winds* and the *prevailing westerlies.* In both the Northern and Southern hemispheres, the trade winds blow from about 30° latitude toward the equator. They come out of the northeast in the Northern Hemisphere and out of the southeast in the Southern Hemisphere. The prevailing westerlies blow from the west between the latitudes of 30° and 60° in both hemispheres. They produce stormy belts of precipitation at about 60° and areas of little precipitation at about 30°. See **Trade wind; Prevailing westerly.**

Tropical cyclones are great circular winds that produce much of the rainfall in the Pacific area. They usually cause little or no damage, and they may bring needed rain to dry areas. However, they occasionally reach such high speeds that they become destructive. A cyclone whose speed reaches 74 miles per hour (119 kilometers per hour) is called a *typhoon* in the northwestern Pacific and a *hurricane* in the northeastern Pacific. Near Australia, it is called a *tropical cyclone.* See **Cyclone; Hurricane; Typhoon.**

El Niño. About every two to seven years, a climate change occurs in the Pacific between 20° north latitude and 20° south latitude. In normal times, the trade winds blow the surface waters from east to west. In the east, deeper cold water rises to the surface to replace the water that is blown away. The cold water is rich in nutrients that increase the growth of the *plankton*—a mass of tiny animals and plantlike organisms that drift with the currents. The plankton, in turn, supports a huge population of fish. As a result, the waters off Ecuador and Peru are one of the world's largest commercial fishing areas.

When the climate changes, the east-to-west winds weaken or may even reverse. As a result, the waters off Ecuador and Peru become abnormally warm. Cold, nutrient-rich water no longer rises to the surface, so the fish population declines sharply.

The interaction of the atmosphere and the ocean during this abnormal period is known as an *El Niño.* During an El Niño, the coast of South America becomes wetter

Facts in brief

Area: About 66 million square miles (171 million square kilometers).

Greatest distances: *North-south*—about 8,570 miles (13,800 kilometers). *East-west*—about 11,000 miles (17,000 kilometers).

Greatest depth: 35,840 feet (10,924 meters), in the Challenger Deep.

Surface temperatures: *Highest,* 88 °F (31 °C), near the equator and in the western marginal seas in summer. *Lowest,* About 32 °F (0 °C), at high latitudes in winter.

than normal, and the climate in Indonesia and other nations of Southeast Asia is unusually dry. An El Niño usually begins in the early summer of one year and extends into the spring of the next year.

An opposite effect called *La Niña* can also occur. During a La Niña, the water in the eastern Pacific, for example, is cooler than it is when there is merely no El Niño.

Both El Niño and La Niña are part of a larger atmospheric pattern known as the *Southern Oscillation.* Oceanic and atmospheric scientists now refer to El Niño as the ENSO (El Niño-Southern Oscillation). See **El Niño.**

Currents. The surface currents in most of the Pacific Ocean are parts of two gigantic, rotating systems of current known as *gyres.* One gyre is centered at about 30° north latitude and rotates clockwise. The other is centered at about 30° south latitude and rotates counterclockwise. Trade winds and prevailing westerlies drive both gyres.

In the Northern Hemisphere, the North Equatorial Current carries warm water from Central America west to the Philippine Sea. There, the gyre turns north as the Kuroshio, or Japan Current, which warms Japan. The North Pacific Current travels east across the ocean and warms western Canada.

In the Southern Hemisphere, the warm South Equatorial Current flows from South America to about the Solomon Islands. From there, the East Australian Current carries warm water south along the coast of Australia and to New Zealand. The Peru Current, also called the Humboldt Current, carries cool water north along the coast of South America to about Ecuador and Peru.

Water masses. Beneath the ocean surface are *water masses,* layers of water with different patterns of circulation. The North Pacific Intermediate Water forms near the surface in the northwestern Pacific. The water becomes cold and dense, so it sinks to greater depths. At depths of 1,600 to 2,600 feet (500 to 800 meters), it spreads out. The North Pacific Intermediate Water flows south to about the equator.

The Antarctic Intermediate Water forms near the southern boundary of the Pacific. It extends northward to about the equator at depths of 1,300 to 4,000 feet (400 to 1,200 meters). The Antarctic Intermediate Water also pushes into the Atlantic and Indian oceans.

Beneath the two intermediate layers is the Pacific Deep Water, whose depth ranges from about 5,000 to 11,000 feet (1,500 to 3,400 meters). This layer moves from north to south throughout the Pacific. The deepest layer is the Pacific Bottom Water. This mass enters the Pacific from the Southern Ocean and flows northward to the northeast Pacific.

Tides. Large tides occur along the Pacific rim. Some of the largest form off the west coast of Korea. There, the water is 15 to 30 feet (4.6 to 9.0 meters) deeper at high tide than at low tide. In mid-ocean, tides are small. For example, at Midway Island, the water level varies by about 1 foot (0.3 meter). See **Tide.**

Ocean life. The oceans contain a complex food web that involves plankton; bacteria; fish; marine mammals, including seals, dolphins, and whales; and animals that live on the seafloor. Seaweeds grow on the seabed in shallow waters. In the tropics, coral reefs support a diverse ecosystem.

An upwelling of water from depths of about 160 to 650 feet (50 to 200 meters) provides nutrients that support ocean life. The cooler subsurface waters are rich in chemical elements and compounds that serve as food for *phytoplankton* (plantlike plankton). *Zooplankton* (planktonic animals) feed on the phytoplankton. Fish, in turn, eat the zooplankton. The major areas of upwelling in the Pacific lie along the coasts of North and South America.

Clams and mussels almost 1 foot (0.3 meter) long and tube worms up to about 10 feet (3 meters) in length live near hot vents. Also living in those areas are species of crabs, fish, and shrimp that are found nowhere else.

Resources. The Pacific provides about half the world's catch of fish and shellfish. Fishing crews in the Pacific harvest more than 50 million tons (45 million metric tons) of seafood annually. About half the catch comes from the northwest Pacific—near China, Japan, and Russia. Other major fishing areas include waters near Southeast Asia, Australia, South America, and North America.

Other products of the Pacific include pearls, seaweed used for fertilizer and in processed foods, tropical fish for aquariums, and minerals. An important source of seafood along the Pacific rim is fish farming, also called *aquaculture* or *mariculture.* Farmers raise fish, shellfish, and seaweeds near ocean shores as well as in ponds.

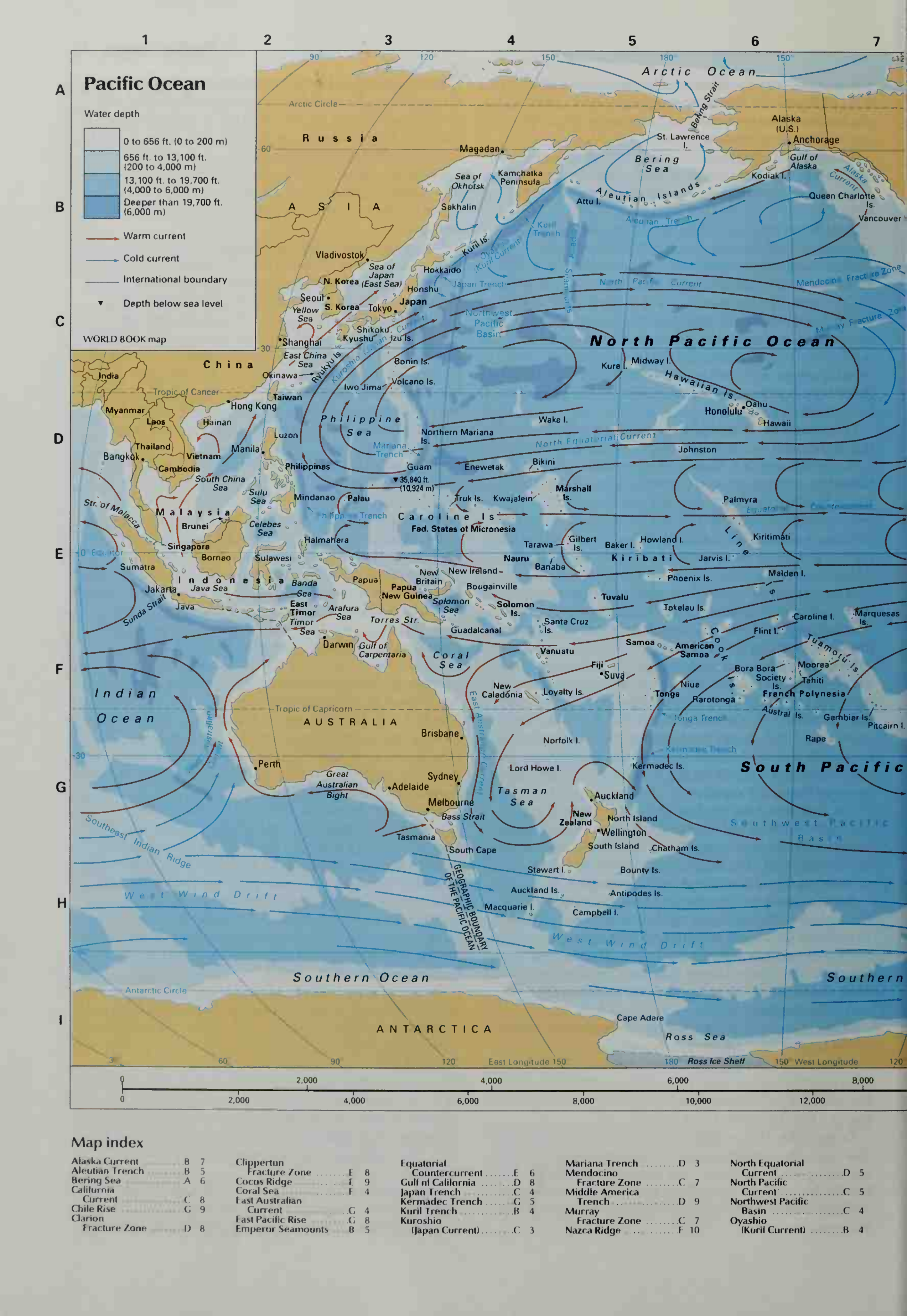
Prospectors have discovered major deposits of petroleum in coastal waters off California, Southeast Asia, and Australia. Offshore oil wells operate in those waters. Natural gas comes from wells on the continental shelves near Russia, Southeast Asia, and Australia.

On the Pacific seafloor are potentially valuable chunks of material known as *manganese nodules.* The nodules are shaped like slightly flattened balls, and most are 2 to 4 inches (5 to 10 centimeters) in diameter. They are about 15 to 30 percent manganese, a metal that is used in the manufacture of steel. The nodules are also 5 to 20 percent iron, and they contain significant amounts of nickel, copper, and cobalt.

Scientific research. Between 1872 and 1876, oceanographers aboard the British scientific ship *Challenger* became the first to study the ocean floor thoroughly. The researchers obtained samples of deep-sea organisms and seabed materials from the Pacific and other areas. They also measured the depth of the seafloor by lowering ropes to the bottom. Scientists continued to measure depth in that way until the early 1900's. At that time, they began to use *sonar,* a process that utilizes sound waves to measure distance.

In 1960, Donald Walsh of the United States Navy and Jacques Piccard, a Belgian oceanographer, descended 35,800 feet (10,900 meters) in the Mariana Trench aboard a *bathyscaph* (diving craft) named *Trieste.* Theirs was the deepest dive ever recorded. In the mid-1970's, geochemists conducted an extensive study of the properties of the intermediate, deep, and bottom waters of the oceans. In 1977, scientists aboard the research submersible *Alvin* made the first discovery of a hot vent. They found the vent on the Galapagos Rift west of Ecuador.

In the 1990's, extensive studies of the Pacific and the other oceans continued. One of the largest was part of an international project called the World Ocean Circula-



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tion Experiment (WOCE). Two major goals of WOCE were (1) to develop and test *computer models* useful for predicting climate change and (2) to develop methods for monitoring long-term changes in ocean circulation. A computer model is a set of mathematical equations processed by computers. In this case, the equations *simulate* (represent) how climate changes.

Scientists want to develop such models to learn more about why the temperature of the air at the earth's surface is becoming warmer. Continued warming could cause environmental and economic damage.

Most of the warming is almost certainly due to human activities, mainly the burning of *fossil fuels* (coal, oil, and natural gas). The burning releases carbon dioxide (CO_2) gas into the atmosphere. Atmospheric CO_2 can increase the surface temperature via a complex process known as the *greenhouse effect.* Researchers are studying the oceans because the oceans absorb atmospheric CO_2. See **Global warming; Greenhouse effect.**

Damage to reefs. Global warming may already be damaging coral reefs. An increase in air temperature raises ocean temperatures, and coral reefs are sensitive to a warming of the water.

A coral reef consists of a mass of the limestone skeletons of small animals called *polyps,* a layer of live polyps attached to the mass and to one another, and algae that live in the polyps' tissue. The algae produce and release substances that serve as food for the polyps. The algae also give coral reefs their distinctive colors.

But when the water becomes unusually warm, the polyps release their algae. As a result, the polyps turn white; they are said to be *bleached.* If the water temperature does not return to normal soon enough, the polyps will die. See **Coral reef.**

Offshore pollution has harmed creatures that live in the Pacific Ocean. Pollutants flow into the ocean from the land and rivers. The pollutants include industrial chemicals, petroleum products, sewage wastes, and artificial fertilizers. Some of those substances contain nutrients and increase the growth of algae in the ocean. Bacteria break down other substances in the water, releasing nutrients.

Even when little or no pollution is present, algae can accumulate into thick layers called *blooms.* Certain algae in the blooms can produce poisons that harm other marine organisms. Those substances can also harm people who eat them in seafood. Many scientists think that nutrients in polluted water cause algae to multiply rapidly, creating extremely thick blooms often called *red tides.* As a result, the poisons can build up to dangerous levels. In the Pacific, huge blooms have occurred near Japan and China. See **Water pollution.** Dana R. Kester

Related articles in *World Book* include:

Atoll
Balboa, Vasco de Núñez de
Bathyscaph
China Sea
Cook, James
Coral
Coral reef
Coral Sea
Cyclone
El Niño
Exploration (Exploring the Pacific)
Fishing industry
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Hot vent
Island
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Ocean
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South China Sea	D	2
South Equatorial Current	E	8
Southwest Pacific Basin	G	6
Tasman Sea	G	4
Tonga Trench	F	5

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Pacifism is a belief that rejects the use of violence. Many pacifists are opposed either to certain wars or to all wars. But in its strictest sense, pacifism means opposition to all violence—even in self-defense—and is called *nonresistance.* The word *pacifism* was coined by Émile Arnaud, a French statesman, in 1901 at the 10th Universal Peace Congress in Glasgow, Scotland. Arnaud was describing the beliefs of men and women who urged the use of international law and diplomacy, instead of war, to settle conflicts among nations.

During World War I (1914-1918), the meaning of the term shifted, especially in the United States and the United Kingdom. At that time, the word came to represent the opposition to all wars, called *absolute pacifism,* or to specific wars. Pacifist groups opposed United States participation in World War I and supported *conscientious objectors*—people whose consciences do not let them take up arms during warfare.

Pacifism has been associated with such major religions as Buddhism, Hinduism, and Christianity. Since the 1600's, the Quakers have been the religious group most closely associated with the belief. Many pacifists, whether religious or not, consider the use of force as degrading to human nature. In addition, pacifists object to the unreasonable and destructive elements of war.

During the 1920's and 1930's, between World Wars I and II, absolute pacifists in the United States and the United Kingdom developed strong antiwar movements. Pacifists supported the organization of the United Nations after World War II ended in 1945.

From the 1950's through the 1980's, European pacifists mounted a series of protests against the nuclear arms race between Western and Communist nations. In the United States during the 1960's and early 1970's, pacifists helped lead the opposition to U.S. participation in the Vietnam War.

Pacifist techniques have also been used to bring about social change. Mohandas K. Gandhi, the leader of India's struggle for independence from the United Kingdom, strongly opposed the use of violence. Instead, he organized nonviolent disobedience to British laws that he believed were unfair. Gandhi's approach became known as *nonviolent resistance* or *Satyagraha.*

During the 1950's and the 1960's, civil rights leader Martin Luther King, Jr., applied Gandhi's approach in working for equality for American blacks. The technique, now known as *nonviolent action,* has been applied elsewhere as well. It was used by some blacks in South Africa before the country was freed in the 1990's from minority white rule. Charles Chatfield

See also **Conscientious objector; Gandhi, Mohandas K.; King, Martin Luther, Jr.; Quakers.**

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Pacino, *puh CHEE noh,* **Al** (1940-), is an American actor known for his brooding, intense acting style. Pacino gained fame in the *Godfather* trilogy of motion pictures. Pacino played Michael Corleone, who becomes the head of a vast organized crime operation. The trilogy consisted of *The Godfather* (1972), *The Godfather, Part II* (1974), and *The Godfather, Part III* (1990). Pacino won the 1992 Academy Award as best actor for his performance in *Scent of a Woman.*

Alfredo Pacino was born in New York City. He dropped out of school at the age of 17 and lived on odd jobs for several years before enrolling in acting school. He won acting awards on Broadway and off-Broadway for his performances in *The Indian Wants the Bronx* (1968) and *The Basic Training of Pavlo Hummel* (1977). He made his movie debut in *Me Natalie* (1969).

Pacino's performance as a drug addict in *The Panic in Needle Park* (1971) led to his being cast in the *Godfather* films. Pacino's other major movies include *Serpico* (1973), *Dog Day Afternoon* (1975), *Scarface* (1983), *Sea of Love* (1989), *Dick Tracy* (1990), *Frankie and Johnny* (1991), *Glengarry Glen Ross* (1992), *City Hall* (1996), the documentary *Looking for Richard* (which he also directed and produced, 1996), *Donnie Brasco* (1997), and *The Insider* (1999). Louis Giannetti

Pack rat. See **Woodrat.**

Packaging is a process essential for the containment and protection of goods. Almost everything that is grown, manufactured, and sold is packaged at some time. Packaging also makes it easy for consumers, shop owners, and distributors to handle products. A package provides information about a product and identifies the product with a distinctive shape, color, and design.

Types of packages include bags, bottles, boxes, crates, drums, pallets, pouches, and sacks. The most commonly used packaging is made of paper and paperboard, such as corrugated boxes, folding cartons, and *composite cans* (paperboard tubes with metal bases). Other major types of packaging include metal packaging, such as aluminum and steel cans; flexible packaging, including aluminum foil and flexible plastic pouches; rigid plastics, which are used in bottles, trays, and caps; and glass.

Manufacturers and designers have developed packages with many convenient features, such as resealable zipper closures and easy-open caps. Lightweight *stand-up pouches* can take the place of cartons and bottles. *Easy open/reseal* and *dosage indicator* caps are used for over-the-counter and prescription drugs. *Modified atmosphere packages* maintain conditions that help prevent the deterioration of such products as premixed salads. *Aseptic packages* are filled in a sterile environment after both the packaging and the product have been sterilized. Such packages are used for medical supplies and such products as milk and fruit drinks. Some containers for use in microwave ovens are made from *susceptor materials.* Such materials help direct microwave energy inside the package to crisp and brown the crust of pizzas or French fries.

The packaging industry is a multibillion-dollar industry worldwide. Suppliers sell finished packaging to industries or organizations, or directly to consumers.

More than half of all packaging is used for food and beverages. Most of the rest is used for other consumer products. Industrial products, such as chemicals and petroleum, use only a small portion of all packaging.

Packaging represents nearly a third of all solid waste production. Thinner, lighter packaging materials and reusable packages can reduce packaging wastes. Recycling also helps reduce wastes. Most packaging materials have some recycled content. *Biodegradable* materials break down in an environment where oxygen, light, and water are available, such as a compost pile (see **Compost**). But most wastes end up in sanitary landfills, where these conditions generally do not exist. Incineration is another option for package disposal. Some plastics produce more energy than coal when burned.

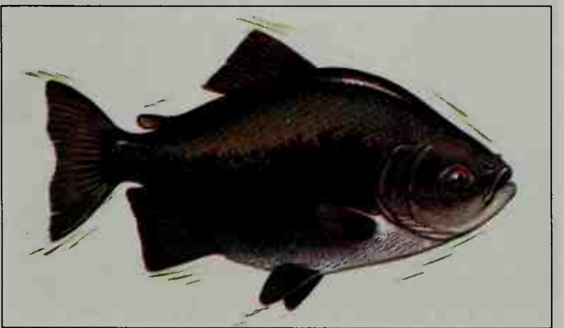
Packaging regulations. Many countries, including the United States, require that every package be accurately labeled to identify the product, the quantity of the contents, and the name and location of the manufacturer, packer, or distributor. The label must describe the nutritional content of any product portrayed as having special nutritional value.

In the United States, the Federal Trade Commission (FTC) and the Food and Drug Administration (FDA) regulate the labeling of consumer products. The FDA approves new materials and additives for use with food packaging. It requires *tamper-resistant,* also called *tamper-evident,* packaging for nonprescription drugs and certain related products. The Consumer Product Safety Commission establishes guidelines for child-resistant packaging and labels for hazardous household products. D. Kay Cooksey

Related articles in *World Book* include:

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Food, Frozen (Packaging)
Food and Drug Administration
Glass (Glass containers)
Industrial design
Paper bag
Plastics (How plastics are used; Plastics and the environment)
Polyethylene
Polypropylene
Tin can
Waste disposal

Pacu, *PA kyoo,* is the common name for several species of South American freshwater fish. Pacus have a narrow, plate-shaped body. Some pacus look much like piranhas, to which they are closely related. However, unlike piranhas, pacus have blunt teeth and eat plants and *plankton* (small, drifting water organisms). Piranhas have sharp teeth and eat fish. Some small pacus are popular for home aquariums.


WORLD BOOK illustration by John F. Eggert

The black pacu is an important food fish in Brazil.

The *black pacu* may grow to more than 3 feet (90 centimeters) long and weigh over 65 pounds (30 kilograms). It is found in rivers throughout the Amazon region. In Brazil, where it is called *tambaqui,* the black pacu is an important commercial food fish. During the long rainy season, adult black pacus migrate far from the main branches of the Amazon River into flooded parts of the tropical forest. There they eat seeds and fruits that fall into the water. When the floodwaters go down, black pacus return to the main river channels. They stay there, eating little, until the next rainy season. Tomio Iwamoto

Scientific classification. Pacus belong to the characin family, Characidae. The scientific name for the black pacu is *Colossoma macropomum.*

Paddlefish is a fish that lives in the rivers and reservoirs of the Mississippi River drainage system. It is a member of a primitive group of fishes having sharklike fins and an oarlike snout that extends out over the mouth. This snout gives the fish its name. The only other surviving member of its family lives in rivers of China. The American paddlefish grows to more than 6 feet (1.8 meters) long and weighs up to 90 pounds (41 kilograms).

The paddlelike snout may be a sense organ, possibly used in locating the tiny organisms called *plankton* on which this fish feeds. The paddlefish catches food by straining water over its gills. A good quality of caviar is made from the fish's *roe* (eggs). The fish's flesh also is valued as food. The paddlefish is also known as the *spoon-billed catfish.* Robert D. Hoyt

Scientific classification. The American paddlefish belongs to the family Polyodontidae. It is *Polyodon spathula.*

Paderewski, *PAD uh REHF skee,* **Ignace Jan,** *EE nyas yahn* (1860-1941), was a Polish pianist, composer, and statesman. During World War I (1914-1918), he left his career as a musician to devote himself to the cause of Polish freedom. At the close of the war, Poland again became independent, largely because of his efforts.

Child prodigy. Paderewski was born in Podolia, now a part of Ukraine. His father was an administrator of estates. His mother was the daughter of a professor. He began his piano lessons at the age of 6. When he was 12, he entered the Warsaw Conservatory. Six years later, he was appointed a professor there.

Paderewski became a pupil of Theodor Leschetizky in Vienna in 1884. In 1887, he began a brilliant career as a concert pianist, playing to enthusiastic audiences in Europe and America. American audiences heard him for the first time in 1891 in New York City. He also played in South America, Australia, New Zealand, and South Africa, as well as throughout Europe. The proceeds of many of his concerts went to charity. He set up the Paderewski Foundation for young composers in 1896 in the United States, and founded two competitions in Warsaw in 1898, for composition and drama. In 1897, Paderewski bought an estate in Switzerland and lived there in his later years.

Polish patriot. Paderewski's devotion to Poland is now a part of history. During World War I, he gave concerts to raise relief funds and helped enlist men for the Polish Army. He represented Poland at the Versailles Peace Conference and the League of Nations. He served as premier, as well as minister of foreign affairs, in the

Polish republic. But political disputes arose, and Paderewski and his cabinet stayed in power only 10 months.

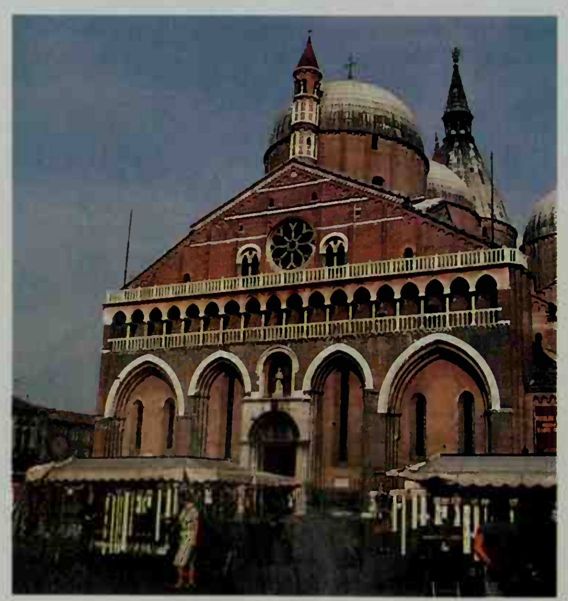
Later career. In 1922, Paderewski resumed his concert performances and teaching. He had given away most of the money he had previously earned to help Poland. He made his last American tour in 1939. After suffering a mild heart attack, he returned to Switzerland. A few months later, Germany invaded Poland, and World War II began. Once more Paderewski devoted himself to the cause of Poland. He was named president of the new Polish Parliament in exile, later called the Polish National Council. Late in 1940, he returned to the United States to make his home on a California ranch. He died in New York City.

Paderewski's compositions include the opera *Manru,* Sonata in A minor for violin and piano, six humoresques for piano, and "Polish Fantasy" and Concerto in A minor for piano and orchestra. His last composition, Symphony in B minor, is a musical picture of the tragic history of Poland. Lydia Hailparn Ledeen

Padlock. See **Lock.**

Padre Island is a barrier island that stretches for about 100 miles (160 kilometers) along the south Texas coast. Laguna Madre, an *estuary* (lagoon), separates it from the mainland (see **Texas** [physical map]). Causeways give access to Corpus Christi and Port Isabel, near Brownsville. Brazos Santiago Pass and the Mansfield Channel connect Laguna Madre to the Gulf of Mexico. The island is a recreational center and wildlife habitat. In 1962, a national seashore was authorized for Padre Island. The island was named for Padre (Father) Nicolás Balli, a Spanish priest who started a ranch there about 1800. See also **Texas** (picture). Daniel D. Arreola

Padua, *PAD yoo uh* (pop. 215,137), stands on the Bacchiglione River, 22 miles (35 kilometers) southwest of Venice (see **Italy** [political map]). It is the oldest city in northern Italy, and its history is rich in architecture, art, and famous people. Many of Padua's narrow, crooked streets are lined with arcades, and several high Roman bridges cross the various arms of the river. The city has many medieval palaces and churches. The Basilica of St. Anthony is a church that dates from the 1200's.



Nawrocki Stock Photo

Padua is the oldest city in northern Italy. The Basilica of St. Anthony, *shown here,* is one of many medieval palaces and churches in the city. The basilica dates from the 1200's.

Padua's art treasures include works by such well-known masters as Giotto, Donatello, and Fra Filippo Lippi. The Roman historian Livy was born in Padua, and at one time Dante lived there. Galileo lectured for 18 years in Padua's university, which was founded in 1222 by Emperor Frederick II. A celebrated botanical garden, the oldest in Europe, is connected with the university.

Today Padua manufactures automobile parts, refrigerators, and other machinery. It has a prosperous trade in fruit, grain, wine, and cattle. Anthony James Joes

Paganini, *PAG uh NEE nee,* **Niccolò,** *NEEK koh LAW* (1782-1840), became one of the greatest violinists of all time. He was just 9 years old when he made his concert debut in Genoa, Italy. From the age of 13, Paganini enjoyed triumphant concert tours. Paganini played quiet melodies so beautifully that his audiences often burst into tears. But he could also perform with such force and speed that a fantastic story began to circulate that he was in league with the Devil, who guided his bow.

Once Paganini won his fame, his life became a combination of artistic triumphs and extravagant living. He once pawned his violin to pay a gambling debt. A French merchant gave him one made by Giuseppe Guarnieri, so that he could play a concert. Paganini left this violin to Genoa, where it is kept in a museum.

At the age of 13, Paganini began to compose pieces for the violin. His works include 24 caprices for violin; two concertos for violin and orchestra, in D major and B minor; and *Moto Perpetuo (Perpetual Motion).* Paganini was born in Genoa on Oct. 27, 1782. Stephen Clapp

Page. See **Knights and knighthood.**

Pager, also called a *beeper,* is a small, wearable device that enables the carrier to receive brief messages while on the move. The idea behind pagers originated with police radio communications in the 1920's. During the 1970's, individuals began carrying pagers for personal use.

A pager is actually a small radio receiver that responds with a tone or vibration when activated by a radio signal. Each pager has its own identification number. A caller can dial the pager number from a telephone or from a computer attached to a modem. The resulting signals travel through the telephone network to a paging terminal. At the terminal, the signals are coded and sent by wire or radio to paging transmitters in the coverage area. The transmitters broadcast the message as a radio signal on a frequency dedicated to the paging service.

Critically reviewed by the Personal Communications Industry Association

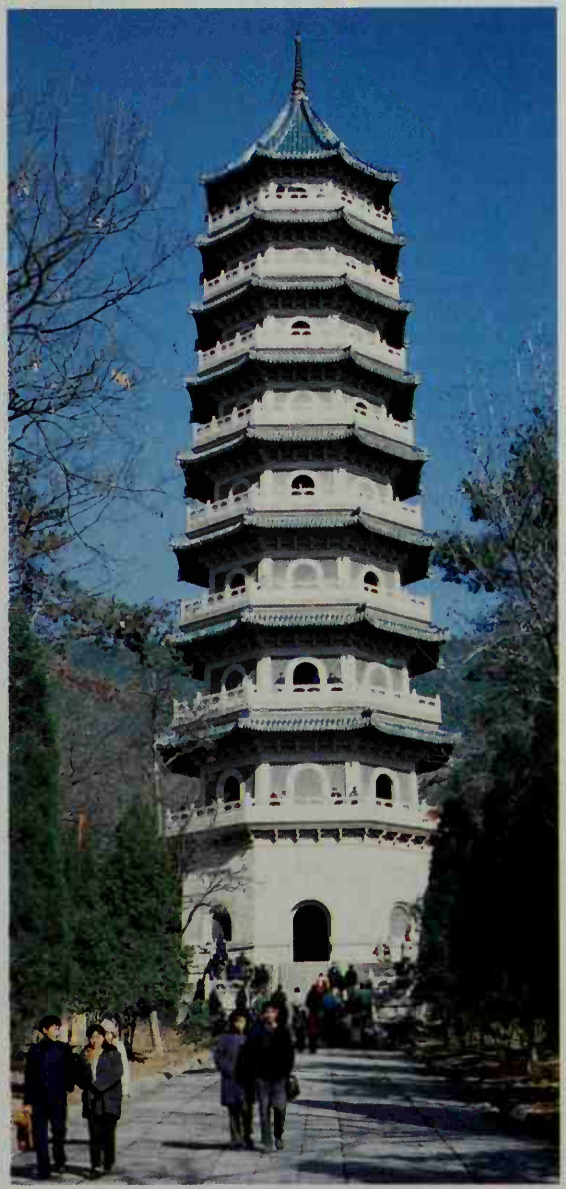
Pagliacci, I. See **Opera** (The opera repertoire).

Pago Pago. See **American Samoa.**

Pagoda, *puh GOH duh,* is a type of tower commonly associated with Buddhist temples. Pagodas exist mainly in China, Japan, and parts of India and southeastern Asia. A typical pagoda has from 3 to 15 stories that decrease in size from bottom to top. Each story of the tower features an overhanging, elaborately decorated tile roof that curves upward at the edges. In many cases, fanci-

fully carved wooden beams and posts support the structure.

In China, most pagodas have eight sides and an uneven number of stories. They are made of wood, masonry, glazed tile, or porcelain and are decorated with ivory, bone, and stonework. Originally, each element in the design of a pagoda had religious meaning. Many Chinese people believed a pagoda brought wealth and happiness to the surrounding community. Japanese pagodas developed from Chinese models. Most Japanese pagodas are made of wood. The ground story may contain shrines and images, and the pagoda's upper stories may be used to view the surrounding area. In Taiwan, many of the pagodas house the ashes of cremated Buddhists.



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A pagoda in Nanjing, China, *shown here,* was built in the 1920's. The nine-story structure has a steel frame and masonry walls.

Pagodas originated in India from the form of Buddhist burial mounds and temples called *stupas.* As Buddhism spread eastward, the pagoda form spread with it. Beginning in the 1600's, imitation pagodas were built in many European gardens. William J. Hennessey

See also Myanmar (The arts; picture); **Temple.**

Pahlavi, Mohammad Reza. See Mohammad Reza Pahlavi.

Pahlavi, Reza Shah. See Reza Shah Pahlavi.

Paige, Satchel (1906?-1982), was one of the greatest pitchers in baseball history. He pitched for touring black teams and teams in the Negro leagues for more than 20 years at a time when blacks were not allowed to play in the major leagues. Paige was past his prime when he joined the Cleveland Indians in 1948 and became the first black pitcher in the American League. He won 6 games and lost 1 that season and helped Cleveland win the pennant. Paige also pitched for Cleveland in 1949 and for the St. Louis Browns from 1951 to 1953. He made a final appearance in 1965, pitching in one game for the Kansas City Athletics. Paige's career major league record was 28 victories and 31 defeats.

Paige was born in Mobile, Alabama. His full name was LeRoy Robert Paige. The exact year of his birth is unknown. Paige earned the nickname of *Satchel* from carrying satchels at the Mobile railroad depot as a boy. He began playing baseball professionally in 1924, and often pitched against major leaguers in exhibition games. In 1937, New York Yankee star Joe DiMaggio called him the greatest pitcher he ever faced. Paige also became famous for his homespun humor. In 1971, Paige was elected to the National Baseball Hall of Fame.

Dave Nightingale

See also **Baseball** (picture).

Pain is an unpleasant sensation that can range from a mild annoyance to an overpowering experience. Pain warns the body about dangerous situations or injuries. Pain that occurs suddenly and fades within hours, days, or weeks after the underlying cause is corrected is called *acute* pain. Acute pain helps survival because people react by trying to avoid the harmful circumstances that cause it. For example, people automatically pull their hands away from an unexpectedly hot object.

Pain that lasts more than a few months is called *chronic* pain. In some cases, the circumstances that cause pain cannot easily be corrected. For example, many people have pain from conditions that cannot be cured, such as arthritis, cancer, and diabetes. The number of people living with chronic pain has grown because the human life span has increased. Many long-term diseases that cause chronic pain become more common as people age. Chronic discomfort interferes with sleep and can lead to depression. Diagnosing and treating chronic pain has gained importance as a medical challenge.

How the body feels pain. Pain is a highly personal experience that involves physical events and psychological factors. No one experiences pain in exactly the same way as anyone else. Pain begins in specialized nerves called *receptors.* Receptors detect sensations of cold, warmth, pressure, and chemical irritation in the body's skin, muscles, blood vessels, and bones. When such sensations become strong enough to damage tissue, cells in the injured area leak certain chemicals. These chemicals activate receptors to send a pain message.

The receptors convert the chemical into an electrical signal. The signal then travels along pain nerves to the spinal cord, and, finally, to the brain. When the message reaches the brain, the person becomes aware of pain.

The path from receptors to the brain is complicated. There are three different types of pain nerves that carry signals from receptors to the spinal cord. In the spinal cord, there are two pain pathways to the brain—one chiefly for acute pain and one chiefly for chronic pain.

Between nerves, there is a tiny gap called a *synapse (sih NAPS).* When the electrical pain signal reaches the end of a nerve, it stimulates the release of chemicals into the synapse. These chemicals cross the synapse and create another electrical message in the next nerve. Many nerves can release chemicals at a particular synapse. The gaps thus provide an opportunity for signals to influence one another as they travel to the brain.

Pain can also be influenced by such psychological factors as excitement or fear. For example, athletes who are extremely excited about a game may be injured without realizing it and continue to play. In contrast, the pain of a medical procedure may be increased by a patient's anticipation and fear of the experience.

Treating pain. Treatment for acute pain aims to remove its cause and provide relief while the body heals. For example, doctors treat a broken leg by setting the bone and giving drugs until the pain of the break subsides. The drugs most commonly prescribed for acute pain include acetaminophen (for example, Tylenol) and a group of drugs called *nonsteroidal anti-inflammatory drugs,* often abbreviated NSAID's (pronounced *EHN sehdz).* Aspirin is the most familiar NSAID. The group also includes such drugs as ibuprofen, sold under Advil, Motrin, and other trade names. For extreme acute pain—for example, after surgery—doctors may prescribe narcotic drugs, such as morphine. Narcotics are also called *opioids (OH pee oydz).*

Doctors use a variety of treatments for chronic pain. Drugs called *antidepressants* may help control chronic pain and improve depression and sleep. Other drugs commonly used to treat seizures also help some patients. In the most severe cases, doctors may prescribe long-term use of narcotics. Narcotics can be taken in several ways, including by mouth or by skin patch. They may also be injected into a vein, a muscle, or directly into the space around the spinal cord. Nelson H. Hendler

See also **Acupuncture; Analgesic; Endorphin.**

Related articles in *World Book* include:

Acupuncture	Drug (Analgesics)	Hypnotism (Uses of hypnotism)
Analgesic	Endorphin	
Biofeedback		

Paine, Robert Treat (1731-1814), an American statesman, was a Massachusetts signer of the Declaration of Independence in 1776. He had been a Massachusetts delegate to the Continental Congress from 1774 to 1776. Paine served as the first attorney general of his state from 1777 to 1790. He helped write the state's Constitution, which was adopted in 1780. He served as a justice of the state supreme court from 1790 to 1804. Paine was born in Boston and graduated from Harvard in 1749. He became a lawyer in 1757. In 1780, he helped found the American Academy of Arts and Sciences. Jack N. Rakove

Paine, Thomas (1737-1809), was a famous pamphleteer, agitator, and writer on politics and religion. His writings greatly influenced the political thinking of the leaders of the Revolutionary War in America (1775-1783), and he became a famous figure in Paris during the French Revolution. "I know not," wrote former President John Adams in 1806, "whether any man in the world has had more influence on its inhabitants or affairs for the last thirty years than Thomas Paine."

Paine's opinions and personality aroused strong feelings in others. Some admired him greatly, but others hated him fiercely. Many historians regard Paine as a patriot who did much for America and asked nothing in return. He stated clearly and concisely political ideas that others accepted and supported, if necessary, to the point of death. Yet Paine died a social outcast.

Early life. Paine was born in Thetford, England. His family was poor, and he got little schooling. He began working at the age of 13. At 19, he went to sea. Later, he served as a customs collector in London, but was discharged. His first wife died, and he was separated legally from his second wife. Paine was alone and poor in 1774. But he gained the friendship of Benjamin Franklin, then in London, who advised him to go to America.

American revolutionary. Paine arrived in America with letters of recommendation from Franklin. Paine soon became contributing editor to the *Pennsylvania Magazine,* and he began working for the cause of independence. In 1776, he published his pamphlet *Common Sense,* a brilliant statement of the colonists' cause. This pamphlet demanded complete independence from Britain and the establishment of a strong federal union. It also contained a brilliant attack on the idea of monarchy and inherited privilege. Paine asserted that the Revolutionary War would begin a new era in world history. "The birthday of a new world is at hand," he wrote. George Washington, Thomas Jefferson, and other colonial leaders read it with approval, as did hundreds of thousands of ordinary Americans. *Common Sense* became the most widely circulated pamphlet in American history to that time.

In December 1776, Paine followed *Common Sense* with a series of pamphlets called *The American Crisis.* The first of these pamphlets began, "These are the times that try men's souls. The summer soldier and the sunshine patriot will, in this crisis, shrink from the service of their country. ... Tyranny, like hell, is not easily conquered." Washington had the pamphlet read aloud to his soldiers. Paine's bold, clear words encouraged the Continental Army during the darkest days of the war.

Paine served as a soldier in 1776. He also worked with a group of Pennsylvanians to create a democratic constitution for the state. In April 1777, he became secretary to the Congressional Committee of Foreign Affairs. His honesty in exposing questionable actions by Silas Deane, American commissioner to France, made him enemies, and Paine was forced to resign his position.

French revolutionary. Paine went to France in 1787 and then to England. While in England in 1791 and 1792, he published his famous *Rights of Man,* replying to Edmund Burke's attack on the French Revolution (see **Burke, Edmund**). William Pitt's government suppressed this work, and Paine was tried for treason and outlawed in December 1792. But he had returned to France.

The National Assembly of France made Paine a French citizen on Aug. 26, 1792. Paine became a member of

the National Convention. But his friends, members called the Girondists, lost power in the Convention. Then he was expelled from the Convention, deprived of his French citizenship, and imprisoned for more than 10 months (see **Girondists**). The American minister, James Monroe, claimed him as an American citizen and obtained his release.

While in prison, Paine worked on *Age of Reason*. It stated his views on religion, and many people called it the "atheist's bible." It began: "I believe in one God, and no more; and I hope for happiness beyond this life." Although Paine believed in God, he disagreed with many accepted church teachings and saw the established churches of Europe as obstacles to social change. His unorthodox views on religion made him one of the most hated men of his time.

Dies neglected. In 1802, President Thomas Jefferson arranged for Paine's return to the United States. Paine found that people remembered him more for his opinions on religion than for his Revolutionary War services. During his last years, Paine was poor, ill, and a social outcast. He was buried on his farm in New Rochelle, but 10 years later his body was removed to England. The location of his grave is unknown. Eric Foner

Additional resources

Fruchtman, Jack, Jr. *Thomas Paine: Apostle of Freedom*. 1994. Reprint. Four Walls, 1996.
Kaye, Harvey J. *Thomas Paine*. Oxford, 2000.
Keane, John. *Tom Paine*. Little, Brown, 1995.
Meltzer, Milton. *Tom Paine*. Watts, 1996.

Paint is a substance that colors and protects a wide variety of surfaces. It is used on the inside and outside walls of buildings, on automobiles, on furniture and household appliances, and on many machines and machine parts. Most paints go on as liquids and then dry to form a thin solid film. A typical coat of paint is about 3\1,000 inch (0.08 millimeter) thick.

Paint consists of one or more finely ground *pigments* and a liquid *vehicle*. Pigments determine the color of the paint and provide it with certain other properties. Pigments commonly used for their color include titanium dioxide (white), iron oxide (yellow or red), phthalocyanine (blue or green), and toluidine (bright red). Manufacturers often add clay, mica, and talc to paint to increase its resistance to wear. These semitransparent materials are called *extenders* or *inert pigments*. Such pigments as zinc phosphate and barium metaborate help paint protect metal surfaces against rust. Pigments composed of fine metal powders give surfaces a metallic finish.

A paint's vehicle carries the pigment and binds it to a surface. Paint vehicles are composed of one or more *resins* and a *solvent*. Resins are sticky substances obtained from plants or manufactured through chemical processes. They are the main ingredient in paint. People often refer to paints by their resin type. Resins include acrylics, alkyds, epoxies, and polyurethanes. Resins largely determine the adhesive quality, drying time, gloss, and hardness of paints. Most are nearly colorless.

The solvent is the ingredient that makes paint a liquid. The solvent depends on the resins used. Most household paints, and an increasing number of industrial paints, use water as a solvent. Other commonly used solvents include mineral spirits, ketones, glycol ethers, and xylene. Solvents are sometimes called *paint thinners*. Vapors given off by some solvents can threaten a user's health, contribute to air pollution, and even play a part in the thinning of the protective layer of ozone in the upper atmosphere. The governments of many countries regulate the use of solvents in paints.

Kinds of paint

There are many kinds of paint. Chemists often classify paints according to the way they *cure* (dry and harden). For example, some paints cure simply through the evaporation of the solvent, which is accompanied by the hardening of the resin. Others form a solid film only after a chemical called a *catalyst* has triggered a reaction to bond the resin particles together. This reaction follows the evaporation of most of the solvent.

Paints are also grouped according to their use. For example, *household paints* decorate and protect houses, office buildings, and other structures. *Industrial paints* are used on a wide variety of consumer products and industrial equipment.

Household paints include paints for the walls, ceilings, floors, and exteriors of buildings. They are sometimes called *architectural paints*.

Most household paints are latex paints. *Latex* (natural rubber) was *emulsified* (evenly distributed) and used as the resin in early *water-based paints*—that is, paints that use water as a solvent. Polyvinyl acetate or acrylic resins have replaced latex in such paints, but these coverings continue to be called latex paints. Latex paints cure by *coalescence*. In this process, the resin molecules bond together to form a dry paint film. This bonding occurs as the water evaporates from the painted surface.

Latex paints are not flammable and have little odor. They dry to a film that can be easily cleaned with soap and water. Interior latex wall paints can tolerate repeated washings, but they are not durable enough for surfaces exposed to the weather. Sunlight can fade paint. Wind, rain, and extremely hot or cold temperatures can cause paint to crack, chip, blister, and peel. As a result,



PPG Industries

A rustproof coating is applied to a new automobile by submerging the car body in a tank of primer for three minutes. An industrial paint later will be baked on over this primer.

exterior house paints have been developed with resins that provide increased resistance to weathering.

Most exterior house paints are latex paints. But some are *oil-based*—that is, they contain resins and solvents obtained from petroleum products, vegetable oils, or linseed or other seed oils. Oil-based paints cure by *oxidation.* After most of the solvent has evaporated, the resins combine chemically with oxygen in the air to form a hard film.

Special paints called *primers, sealers,* or *undercoaters* are used when painting such porous surfaces as bare wood or plaster. Primers are applied as the first coat to form a smooth base for the final coat of paint.

The United States government restricts the content of lead pigments in household paint to 0.06 percent by weight of the dried film. This restriction was first applied in 1977, after the discovery that some children had developed lead poisoning after being exposed to paint with a high lead content. The affected children ate chips of dried paint with a high lead content, or swallowed or inhaled dust containing particles of this paint.

Industrial paints are used on such consumer products as automobiles, furniture, and household appliances. They also include coatings that protect machinery and other industrial equipment against moisture, strong chemicals, rust, and extremely high temperatures.

Most automobile manufacturers paint their cars with highly specialized coatings that contain acrylic resins and cure when they are baked on. Many kitchen and laundry appliances also have baked-on finishes. Such coatings produce an extremely hard surface that is resistant to harsh chemicals and does not dull or fade easily.

Manufacturers of wooden furniture often use wood stains on their products. The pigments in wood stains are highly transparent. They are dissolved in a vehicle that enables the stain to soak into the wood rather than stick to its surface as a film. Stains darken the color of wood but allow the wood grain to show through. After staining wood, manufacturers apply a clear, protective finish, often using lacquer or shellac. These finishes cure by *solvent evaporation*—that is, the resins solidify into a hard coat as the solvent evaporates. These finishes dry quickly and produce a shiny surface. After they have hardened, such finishes can be redissolved with the same solvents originally used in the vehicle. Manufacturers finish some wood products with varnish, a clear, oil-based coating that dries by oxidation.

Iron and steel may rust if they come in contact with moisture and oxygen. For this reason, manufacturers coat many products made of iron or steel with special rustproof primers and finish coats. Metal primers have high proportions of rust-resistant pigments. Some of these paints contain ingredients that penetrate rust to drive out oxygen and moisture. Finish coats cover the metal primer and seal it. In general, the primer protects the metal and the finish coat protects the primer. Manufacturers cover some metal products with enamels, which contain alkyd resins and dry by oxidation.

The most durable coatings available are generally used on machinery and other industrial equipment. They are often based on epoxy or polyurethane resins, which cure by chemical reaction. The chemical industry uses a number of such paints to protect the surfaces of pipes and containers that are used to store or carry harsh chemicals. Chemical companies have developed special heat-resistant coatings for high-speed aircraft, space vehicles, and equipment used in certain industrial processes. Some of these special paints can withstand temperatures as high as 1200 °F (650 °C).

How paint is made

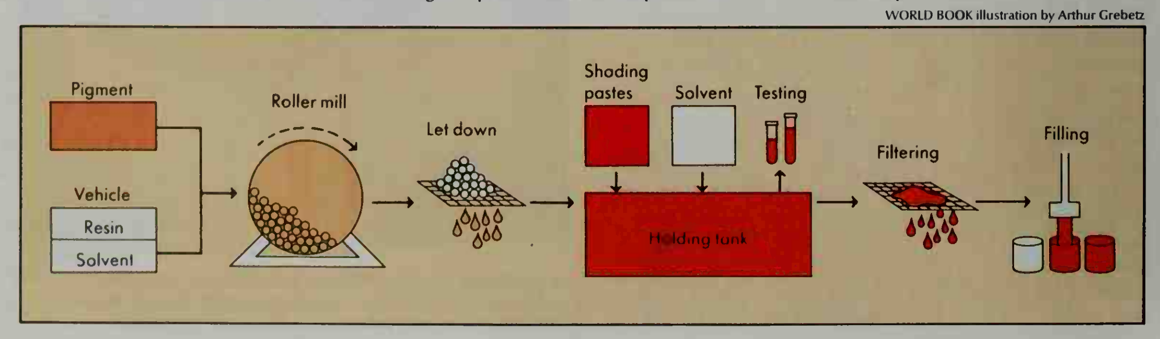
All paints are manufactured according to a similar process. The basic steps of this process are (1) grinding, (2) let down, (3) shading, and (4) thinning.

Grinding. Batches of paint vary in size, but many batches are as large as 1,500 gallons (5,700 liters). To produce a batch of paint, manufacturers first load an appropriate amount of pigment, resin, and liquid chemicals into one of several types of grinding mills. The mill grinds the liquid and dry ingredients into a fine, uniform material called *mill paste.*

Manufacturers choose a mill according to the hardness of the pigments and the fineness of grind required for the paint. Latex house paints are usually prepared in a mill called a *high-speed disperser.* This mill has circular blades with saw-toothed edges. The blades rotate at high speeds, causing the pigment particles to collide with one another and break into smaller pieces.

How paint is made Paint is made by mixing colored pigment powder in a liquid *vehicle* that contains one or more resins and a solvent. The pigment and vehicle are made into a fine paste by the tumbling action of balls or pebbles in a ball mill. During *let down,* the paste is pumped from the mill and strained. In a holding tank, the color is adjusted by adding shading pastes, and the mixture is thinned with solvent. After final testing, the paint is filtered and poured into containers for shipment.

WORLD BOOK illustration by Arthur Grebetz



Other mills have a large, rotating steel cylinder partly filled with pellets or particles called *grinding media. Ball mills* contain steel balls that measure about $\frac{5}{8}$ inch (1.6 centimeters) in diameter. *Pebble mills* contain flattened ceramic balls about 1 $\frac{3}{8}$ inches (3.5 centimeters) in diameter. As the mill turns, the grinding media tumble against one another, crushing the pigment between them. Most of these mills rotate at about 16 revolutions per minute. The grinding process may last 24 hours.

Sand mills or *bead mills* can produce fine grinds faster than other mills. These mills shoot tiny glass beads through the pigment at high speeds. The mills can supply finely ground paste continuously or in batches.

Let down. After grinding the pigment, the paint maker adds more resin to the paste in the mill, along with a small amount of solvent. The paste is then "let down"—that is, it is pumped out of the mill through a strainer to a holding tank. The strainer removes the grinding media or other foreign matter from the paste. Workers rinse the mill with more solvent, which is then mixed with the rest of the material in the holding tank.

Shading, also called *tinting,* probably requires more care than any other step in the manufacturing process. In this step, paint producers compare samples of the material in the holding tank with color standards they keep on file. They then add small amounts of *shading paste* to the batch to adjust its color to the standard. Shading pastes are highly concentrated blends of ground pigments and a vehicle.

Thinning. After the batch has been shaded to specification, the paint maker thins it to the desired *viscosity* (thickness) by carefully adding solvent to it. Manufacturers then test the final product for quality. Finally, they filter the paint and pour it into containers for shipment.

How to use household paint

Selecting the paint. Household paint comes in flat, semigloss, and gloss finishes, and in a wide variety of colors. The nature of the surface to be covered plays an important role in choosing the finish and color of paint. For example, a single coat of paint is often sufficient when covering a similar color. But two or more coats may be required when painting over a different color. Flat paints, also called *dull* or *matte* paints, help hide flaws on surfaces. Gloss finishes, on the other hand, are smooth and shiny, and they readily show any surface defects. However, gloss paints are more durable than flat paints. Paints with intermediate levels of gloss are often called *eggshell, satin,* or *velvet.*

Preparing the surface. Poor surface preparation is the most common cause of paint failure. For paint to stick properly, the surface to be painted must be free of dirt, dust, grease, loose paint, moisture, oil, and wax. Often, washing a surface with soap and water is sufficient. But some surfaces may require scraping, brushing with a wire brush, or sanding. Others may also have cracks or holes that should be filled and sealed.

Stirring and filtering. Paint often settles. Always stir paint before applying it to ensure that it has a uniform consistency. One of the best methods is to stir in a figure-eight motion with a paint paddle. Lift the paddle occasionally to raise heavy pigments from the bottom of the can. Before painting, many people strain paint through a special paint filter, a fine screen, or a nylon stocking. This procedure is especially helpful when using old or leftover paint, which might contain dirt, rust from the can, or pieces of dried paint film.

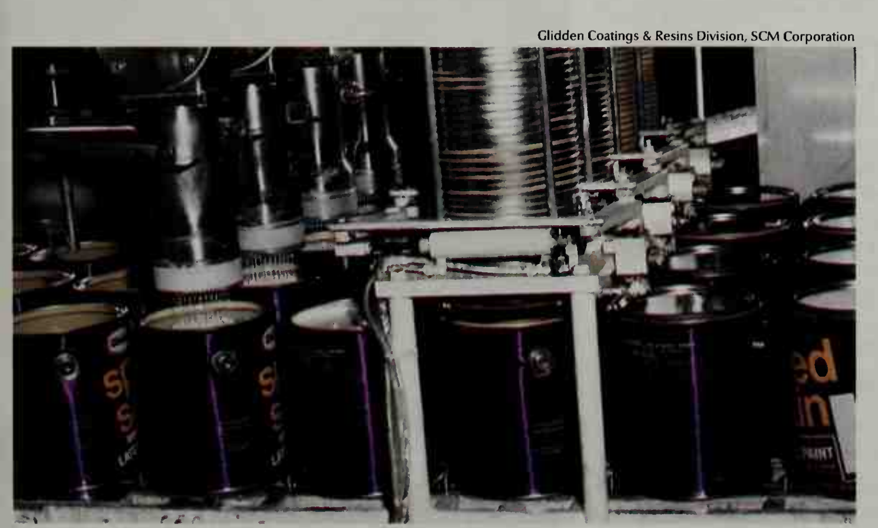
Applying the paint. Paint may be applied with brushes, spray equipment, rollers, or paint pads. Small objects and irregular surfaces can best be painted with brushes or sprayers. Large, flat surfaces can be painted faster with sprayers, rollers, or paint pads.

Brushes are made of hog bristles or synthetic fibers. Hog-bristle brushes are used to apply oil-based paints. Synthetic-fiber brushes may be used to apply either oil-based or latex paints. To prevent streaking, spread the paint on a dry area and then brush it toward the wet edge of a previously painted area.

Spray painting produces a smooth coat of paint. Spray-painting equipment causes thinned paint to form droplets under pressure. When spraying paint, wear filter masks to avoid inhaling paint mist and vapor. Cover all surfaces that are not to be painted to protect them from the fine spray.

Rollers hold paint in fibers, the length of which determines the *nap* of the applicators. Rollers with short naps

Glidden Coatings & Resins Division, SCM Corporation



Filling cans with paint is done automatically. This machine fills and covers ninety 1-gallon (3.8-liter) cans a minute. After handles are applied, the cans of paint are ready for shipment.

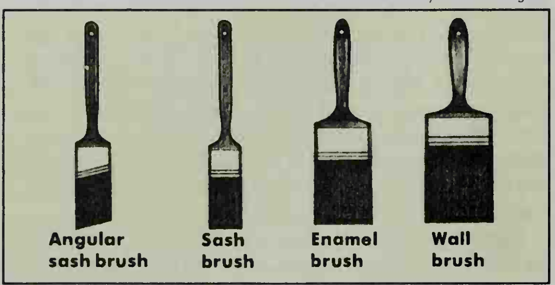
are suitable for applying thin paints on smooth surfaces. Long-napped rollers work better for thicker paints and textured surfaces. To produce an even coat, roll paint onto the surface in crisscross and up-and-down strokes. Each rolled strip of paint should overlap the wet edge of the previously painted area to avoid streaks.

Paint pads are made of foam, mohair, or synthetic fibers. They hold a large amount of paint and apply smooth coats of paint.

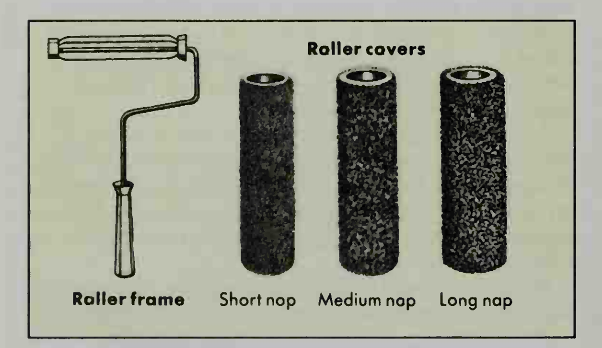
Types of paint applicators

Paint may be applied with brushes, rollers, spray guns, or pads. The choice of which type of applicator to use depends on the size, shape, and texture of the surface to be painted.

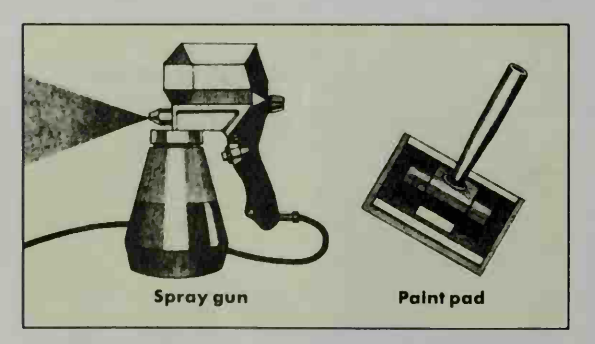
WORLD BOOK illustrations by David Cunningham



Paint brushes are especially good for painting small objects or irregular surfaces. Narrow sash brushes can reach into tight corners. Wider brushes are used for broad areas, such as walls.



Paint rollers paint large, flat surfaces quickly. Roller covers that have short fibers, or a short *nap,* are good for painting smooth surfaces. Covers with a longer nap are used for rough surfaces.



Spray guns and paint pads allow quick coverage of large areas. In addition aerosol spray cans easily paint small objects and irregular surfaces.

The history of paint

Prehistoric people made paints by mixing vegetable and earth pigments with water or animal fat. They painted on cave walls, on tombs, and on their bodies. Some caves in western Europe have walls that were painted about 30,000 years ago.

By 2000 B.C., the Egyptians painted tombs with materials similar to paints made today. These paints were made of crudely refined pigments, natural resins, and drying oils. The Egyptians imported pigments from as far away as India. By 1500 B.C., painting and paint making had become known in Crete and Greece.

The Romans learned how to make paints from the Egyptians. After the fall of the Roman Empire in the A.D. 400's, paint making became a lost art until the English began making paints near the end of the Middle Ages. They used paints chiefly on churches at first, and later on public buildings and the homes of wealthy people.

During the 1400's and 1500's, Italian artists and craftworkers developed their own paint-making processes. Unfortunately, they kept their formulas secret, and so the process of making a particular paint often died with its inventor.

The commercial manufacture of paints began in Europe and the United States during the 1700's. The early manufacturers of paint ground their pigments on a stone table with a round stone. The American colonists made their own paints using such materials as eggs, coffee grounds, and skim milk. They thinned these paints with water. In the late 1800's, grinding and mixing machines were developed that enabled manufacturers to produce large volumes of paint.

Improvements in paint technology closely paralleled advances in chemistry during the 1900's. Chemical companies developed many synthetic resins and a number of new pigments. Paints became increasingly specialized to meet the specific demands of industry.

George J. Danker

Related articles in *World Book* include:

Airbrush
Brush
Calcimine
Chrome
Cobalt
Color
Enamel
Lacquer
Lead
Lead poisoning
Linseed oil
Ocher
Oil
Painting (Materials and techniques)
Pigment
Resin
Resin, Synthetic
Shellac
Stain
Talc
Titanium
Tung oil
Varnish
Vegetable oil

Painted Desert is a brilliantly colored plateau region extending about 200 miles (320 kilometers) along the Lit-



Esther Henderson, Rapho Guillumette

The Painted Desert, a wasteland of striking color, covers a large area in north-central Arizona. Its hills and terraces reveal brilliant shades of blues, reds, and yellows.

tle Colorado River in north-central Arizona. For location, see **Arizona** (physical map).

The desert received its name from early Spanish explorers, who called it *El Desierto Pintado,* meaning *The Painted Desert.* It is a fantastic wasteland, with buttes, mesas, pinnacles, and valleys formed by ages of wind and rain cutting into shalelike volcanic ash. The pastel colors of the desert add to its beauty, especially because heat, light, and dust often seem to change the colors from blue, amethyst, and yellow to russet, lilac, and red. The Painted Desert is particularly beautiful at sunrise and sunset, when the colors are the most brilliant and the shadows the deepest. The bright reds and yellows of the desert come from iron oxides—hematite (red) and limonite (yellow).

Several national monuments are in the Painted Desert. These include the Sunset Crater and Wupatki national monuments. John Edwin Coffman



R. Elich, Artstreet

The painted-tongue has trumpet-shaped blossoms with velvety looking petals. These blossoms have a wide range of colors and have made the painted-tongue a favorite garden flower.

Painted-tongue is a garden plant with large, trumpet-shaped blossoms. The blossoms, which resemble those of the petunia, have a wide range of colors, including deep red, pink, purple, brownish orange, salmon, yellow, and white. The petals have a rich velvety sheen and are often streaked with yellow and other colors. The painted-tongue has long, narrow leaves. It grows about 18 inches (46 centimeters) high and has several flowers near the top of each stalk. Native to Chile, the plant grows well in cool climates. It must be planted from seed each year.

Scientific classification. The painted-tongue belongs to the nightshade family, Solanaceae. Its scientific name is *Salpiglossis sinuata.* William G. D'Arcy

Painter refers to the artist who paints pictures, and also to the skilled worker in the building trades. Painters on construction projects work on both the outside and the inside of a structure. There are other opportunities for the skilled painter. A person with a talent for color and design may become an interior designer. Many painters go into business for themselves.

For biographies of artists who are painters, see the *Related articles* at the end of the **Painting** article.

Painter's colic, sometimes called *lead colic,* is a severe pain in the abdomen that results from lead poisoning. The pain is often accompanied by constipation or vomiting. Lead in paint can enter the body through the skin, or children may swallow lead paint that peels from walls. Lead vapors also may be inhaled. Scientists do not know why lead poisoning causes abdominal pain. See also **Lead poisoning.** James L. Franklin

Painting

Painting is one of the oldest and most important arts. Since prehistoric times, artists have arranged colors on surfaces in ways that express their ideas about people, the world, and religion. The paintings that artists create have great value for humanity. They provide people with both pleasure and information.

Sometimes artists paint primarily for their own enjoyment or self-expression, choosing their own subjects. Artists may also paint for a supporter called a *patron,* who *commissions* (orders and pays for) a work. A patron may be a private individual or a ruler who wants to decorate a palace or give the painting as a gift. A patron also may be an organization or institution. Religious groups have commissioned works of art to help believers worship and understand their faith. Rulers use art to assert their importance. Governments use painting to teach people about the history and ideals of their country.

Even when artists paint primarily for themselves, they want others to see their work and understand and enjoy it. People enjoy paintings for a number of reasons. Many viewers take pleasure in the artistic qualities of a painting, such as its colors or composition. Some paintings interest viewers because of the way the artists have expressed some emotion, such as fear, grief, happiness, love, hero worship, or faith. Such paintings, in turn, can inspire similar emotions in people looking at them. Other paintings are enjoyable because they skillfully portray nature or illustrate the daily lives of people who lived long ago.

Paintings can also teach. Some paintings reveal what the artists, their patrons, or their society felt about important subjects, including death, love, religion, and social justice. Many paintings tell about the history of the period in which they were created. They provide information about the customs, ideals, and interests of people of past societies. Much of our knowledge about prehistoric and ancient times comes from paintings and other works of art because many early cultures left few or no written records. For example, paintings can tell about such things as the architecture, clothing, recreation, and tools of a particular society or historical period.

What painters paint

It would be very difficult to find a subject that no one has ever tried to paint. Artists paint the things they see around them—people, animals, nature, and objects. They also paint dreamlike scenes that exist only in the imagination. An artist can reach back into the past and paint a historical event, a religious story, or a myth. Some artists paint pictures that show no recognizable subject matter at all. Instead, they arrange the paint in some way that expresses feelings or ideas that are important to them.

The subject of the French artist Georges Seurat's *Sunday Afternoon on the Island of La Grande Jatte* (page 29) is a crowd of French people relaxing in a park along the Seine River near Paris. But the artist did not intend only to capture an informal portrait of the life of his day. Seurat painted the scene with tiny dots of unmixed color

Text continued on page 31



National Gallery of Art, Washington, D.C., Andrew W. Mellon Collection

The Annunciation
by Jan van Eyck
About 1436. Oil on canvas, transferred from wood.
$35\frac{3}{8}$ by $13\frac{3}{8}$ in. (90 by 34 cm).



Mountains and Sea by Helen Frankenthaler
1952. Oil on canvas. 7 ft. 2 $\frac{5}{8}$ in. by 9 ft. 9 $\frac{1}{4}$ in. (2.20 by 2.98 m).



Alte Pinakothek, Munich, Germany (SCALA/Art Resource)

Battle of the Amazons by Peter Paul Rubens
1618. Oil on canvas. 47 $\frac{3}{4}$ by 65 $\frac{1}{4}$ in. (121 by 166 cm).

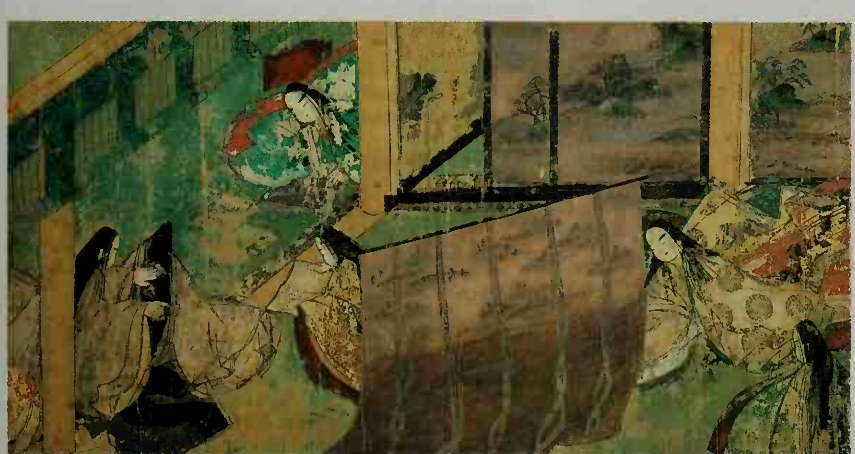
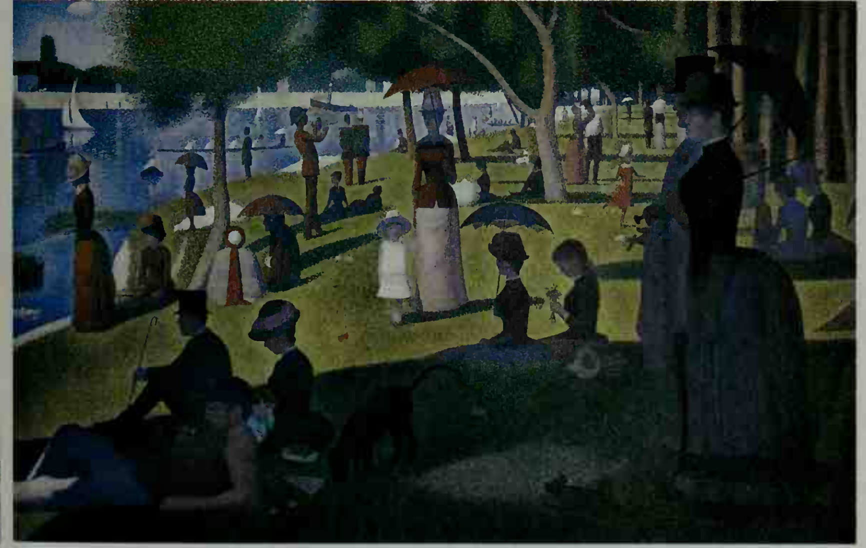


Illustration from *The Tale of Genji* by an unknown Japanese artist
1100's. Ink painting and color on a paper hand scroll.
8 $\frac{1}{2}$ by 15 $\frac{3}{8}$ in. (22 by 39 cm).

Tokugawa Art Museum, Nagoya, Japan

The Art Institute of Chicago, Helen Birch Bartlett Memorial Collection



Sunday Afternoon on the Island of La Grande Jatte by Georges Seurat
1886. Oil on canvas.
6 ft. 9 in. by 10 ft. $\frac{3}{8}$ in. (2.06 by 3.06 m).

Famous artists and their paintings

The paintings reproduced in this article are listed below. These pictures were selected to represent the most important periods and styles in the history of painting. Each reproduction is accompanied by the following information, when available: the year the painting was finished, the medium in which it was created, its size, and its present location.

Painter, painting, and page number

placed side by side. Seen from a distance, the dots are meant to blend in the viewer's eye. In this painting, Seurat was really expressing his belief in new theories about color vision that were being advanced during his lifetime.

Since prehistoric times, many artists have painted the subjects that were most important to their societies. For example, religion was particularly important in Europe during the Middle Ages, and most of the paintings created then had religious themes.

All great paintings, regardless of subject matter, share a common feature. They do more than just reproduce with paint something that exists, existed, or can be imagined. They also express the painter's special view about a subject.

People have always been a favorite subject of painters. A portrait may show an individual or a group of people, or it may be a self-portrait of the artist. The people may appear alone, in religious or historical scenes, or in *genre paintings* (scenes of everyday life). The presence of people in a portrait can establish a bond between the viewer and the picture. The viewer can be drawn into the painting by eye contact with the subject or out of sympathy, amusement, or even adoration if the painting portrays a hero or religious figure. The English artist Thomas Gainsborough painted a double portrait called *Mr. and Mrs. Andrews* (page 32). The open, friendly gaze of the subjects invites the viewer into the world of their English country estate.

The French artist Honoré Daumier used people for an entirely different reason in *The Uprising* (this page). Daumier's people are taking part in the Revolutions of 1848, a series of revolts by the lower classes in Europe. Daumier was not interested in showing details of his subjects' clothing or surroundings. Instead, he crowded the people together in a scene that suggests action. He made the people seem more like symbols of the revolutionary spirit than like real human beings.

The two people in Austrian artist Oskar Kokoschka's *The Tempest* (this page) are caught up in a mysterious swirling scene that cannot be explained in a logical way.

About this article

This article traces the history of painting from its beginnings to the present day. It starts with a discussion of the subjects painters paint, the elements of painting, and the materials and techniques used by painters. The outline below shows the major sections of the article. *World Book* also has many individual articles on important painters and movements in the history of painting. Cross-references within the article refer to other *World Book* articles for examples of paintings. A listing of *Related articles* at the end of the article leads the reader to more information on artists and movements.

Article outline:

The contributors of this article are Ann Friedman, Education Specialist at the J. Paul Getty Museum; Valerie Lind Hedquist, Assistant Professor of Art at Central College in Pella, Iowa; Joseph F. Lamb, Assistant Professor of Art at Ohio University; Vernon Hyde Minor, Associate Professor of Art History and Humanities at the University of Colorado; Michael Plante, Assistant Professor of Art at Tulane University; Henry M. Sayre, Professor of Art at Oregon State University; Marilyn Stokstad, Judith Harris Murphy Professor of Art History at the University of Kansas; Elizabeth deS. Swinton, Curator of Asian Art at the Worcester Art Museum; and Marjorie S. Venit, Associate Professor of Art History at the University of Maryland.



Kunstmuseum, Basel, Switzerland (Colorphoto Hinz SWB)

The Tempest by Oskar Kokoschka
1914. Oil on canvas.
5 ft. 11 ½ in. by 7 ft. 3 in. (1.81 by 2.21 m).



The Phillips Collection, Washington, D.C.

The Uprising by Honoré Daumier
About 1848. Oil on canvas.
34 ½ by 44 ½ in. (88 by 113 cm).



National Gallery, London

Mr. and Mrs. Andrews by Thomas Gainsborough
About 1748. Oil on canvas.
27 ½ by 47 in. (70 by 119 cm).

The artist painted the people in this way to show how powerful emotions apparently swept the couple away from the activities of everyday life.

The treatment of people in painting can range from extremely realistic to nearly *abstract,* a style that emphasizes shapes, colors, and patterns instead of recognizable subject matter. The American artist Chuck Close's lifelike *Big Self-Portrait* (page 34) was created with the help of photographs. It realistically emphasizes every feature of the artist's unshaven face, demanding our attention by its huge scale. In contrast, the American artist Willem de Kooning painted *Woman, I* (page 85) in an almost abstract style to create a savage vision of the subject.

Religious subjects dominated painting in some parts of the world for hundreds of years. A large number of all the pictures ever painted in Asia are religious. European painters of the Middle Ages and the Renaissance painted more religious pictures than any other kind.

Paintings have played an important part in religious rituals and worship. These paintings have taken a number of forms, including altarpieces and illustrations in prayer books and books of psalms. Worshipers have carried some paintings that they considered especially holy in religious processions.

Paintings have honored deities and saints and also encouraged religious feeling, which could be expressed as adoration, sorrow, joy, or horror. The Flemish painter Jan van Eyck's *The Madonna and Child with Chancellor Rolin* shows the chancellor praying in his room. As he looks up, he sees the Virgin Mary and the infant Jesus before him. This painting appears in the **Renaissance** article.

Paintings can also portray the lives of gods and holy people. Many paintings commemorate the birth, ministry, Crucifixion, and Resurrection of Jesus Christ. Examples appear in the **Jesus Christ** article. Religious paintings can also teach moral lessons. Michelangelo's *The Last Judgment* shows the eternal happiness that rewards the faithful and the horrors of hell that will be the punishment of sinners. This painting appears in the **Religion** article.

Landscapes and seascapes depict the appearance, power, and atmospheric effects found in nature. The American artist Fitz Hugh Lane recorded the effects of



Museum of Fine Arts, Boston, Massachusetts, Karolik Collection of American Paintings

Owl's Head, Penobscot Bay, Maine by Fitz Hugh Lane
1862. Oil on canvas.
16 by 26 in. (41 by 66 cm).

light and space on a clear, calm morning on the New England seacoast in *Owl's Head, Penobscot Bay, Maine* (page 32).

Landscapes and seascapes also reflect the importance of land ownership and seafaring. In Gainsborough's *Mr. and Mrs. Andrews,* the country estate takes up more space than the human figures, symbolizing the importance of the land to the couple. In the Netherlands during the 1600's, seascapes were popular subjects because much of the country's wealth and power depended on sea trade.

Chinese artists portrayed the beauty of mountains in landscapes painted in ink on paper or silk and mounted on scrolls. An example is *Travelers Among Mountains and Streams* (page 34) by Fan Kuan. The artist intended viewers to journey slowly through the painting with their eyes. Wandering through the picture, viewers closely observe its mountain formations, waterfall, trees, village, and tiny figures of travelers. In Japan, makers of an early type of kimono called the *kosode* sometimes painted landscapes on the garments, such as *Kosode with Plum Tree and Flowering Plants* (this page) by Sakai Hoitsu.

Sometimes artists used landscape paintings as extensions of real nature. Many Roman gardens had landscapes painted on their walls to extend the real garden by means of make-believe.

Still-life paintings are close-ups of objects. The objects can be natural, such as fruits and vegetables, or manufactured, such as bottles and rifles. Many still lifes express the bounty of nature and the harvest, or the wealth of patrons or the artist's society. In the 1600's, European painters often showed fish shops and vegetable stalls overflowing with goods. In the Netherlands during that time, some still-life artists painted arrangements of food called *breakfast pieces.* An example is *Breakfast Table* (page 64) by Willem Claesz Heda.

Some artists have painted precise, minutely realistic still lifes called *trompe-l'oeil (fool the eye).* Some artists have made formal, almost abstract compositions of still lifes. One example of this is *The Bottle of Banyuls* by Spanish artist Juan Gris. This painting appears in the **Cubism** article.

Because flowers and fruits eventually wither and die, artists have sometimes used them to express the passing of time and the decay of matter. In this way, the paintings remind viewers of their own aging and future death.

History paintings show important events from the artist's own times or from the past. Such paintings can portray significant occasions in a nation's history. John Trumbull painted *The Declaration of Independence* only a few years after this event took place. The artist actually knew many of the signers. This painting appears in the **Declaration of Independence** article.

Often a ruler commissions a painting to glorify himself or herself as well as the country. Napoleon I of France made Jacques Louis David his official painter to glorify his reign.

Scenes from Greek and Roman history were popular in European painting because the Europeans considered ancient Greece and Rome the ancestors of their civilization. Sometimes, artists used subjects from ancient times to make a moral or patriotic statement ad-



National Museum of Japanese History, Chiba prefecture, Japan, Nomura Collection
Kosode with Plum Tree and Flowering Plants by Sakai Hoitsu
Late 1700's. Painting on silk.
Robe about 5 ft. (1.5 m) long.



Collection of the J. Paul Getty Museum, Malibu, California
Dinos by an ancient Greek artist known only as the Dinos Painter
About 470 B.C. Painting on terra cotta.
Bowl 14 $\frac{5}{8}$ in. (37 cm) high.

dressed to the viewers of their own day. An example is David's *The Oath of the Horatii* (page 67). The painting portrays three brothers vowing to their father to fight for the Roman Republic, even though their decision will bring sorrow to their families. The artist is telling the viewer that public duty, self-sacrifice, and patriotism are more important than an individual's or a family's personal interests, safety, or happiness.

Mythology paintings tell stories of gods and goddesses. For example, an ancient Greek artist known only as the Dinos Painter painted a mythological scene on a *dinos,* a large bowl for holding wine (page 33). The god Triptolemos, in the center, is about to depart in his winged chariot drawn by a snake to teach humanity how to cultivate grain. He and the goddess Demeter hold stalks of wheat. At the right, Demeter's daughter Persephone offers a bowl of wine in honor of the god's departure.

Social expression has been a common theme throughout art history. Many artists have painted pictures that express political beliefs or attack social ills, such as war and poverty. The Spanish artist Francisco Goya protested the cruelties of war in such works as *The Executions of 3rd May, 1808* (page 68). The painting shows civilians being executed by a military firing squad.

Decoration has been an application of painting since prehistoric times. Almost all ancient Greek paintings that survive are those that decorate pots, vases, and other ceramics. For centuries, people have hung paintings on the walls of homes as decoration. Wallpaintings decorated the interiors of many palaces and public buildings during the Renaissance in Italy. For an example by the Italian artist Andrea Mantegna, see the **Fresco** article.

Abstract painting deliberately omits recognizable subject matter. Instead, the artist explores form, color, design, pattern, and texture. Some abstract paintings still express a meaning, even without identifiable subject matter. The American artist Robert Motherwell painted *Elegy to the Spanish Republic LV.* The abstract painting is one of a series that expresses the artist's sorrow over the Spanish Civil War (1936-1939). It appears in the article **Motherwell, Robert.** Many abstract paintings, on the other hand, have no meaning. An abstract picture called *Mountains and Sea* (page 29) by the American artist Helen Frankenthaler has no significance other than the artist's interest in color and texture.

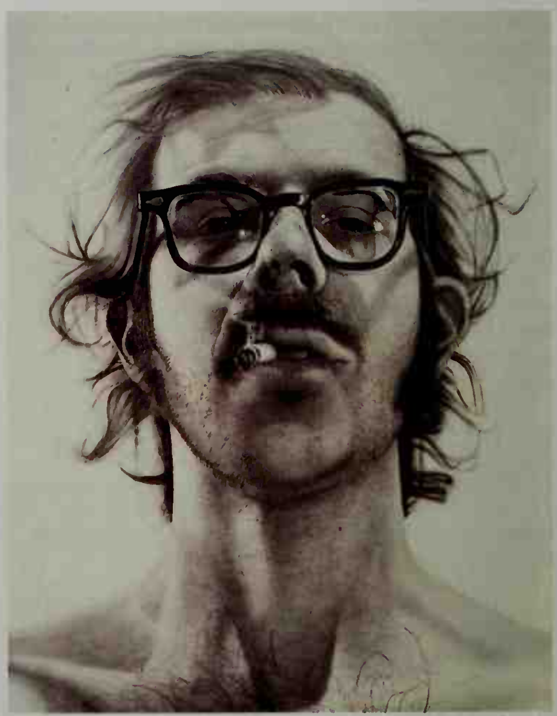
The elements of painting

Paintings consist of many artistic elements. The most important elements are (1) color, (2) line, (3) mass, (4) space, (5) texture, (6) composition, and (7) light and shade. These artistic elements are as important to a painter as words are to an author. By stressing certain



National Palace Museum, Taipei, Taiwan

Travelers Among Mountains and Streams by Fan Kuan
Early 1000's. Painting on a fabric scroll.
6 ft. 9 ½ in. (2.07 m) high.



Walker Art Center, Minneapolis, Minnesota

Big Self-Portrait by Chuck Close
1968. Acrylic on canvas.
8 ft. 11 ½ in. by 6 ft. 11 ½ in. (2.73 by 2.12 m).

elements, a painter can make a picture easier to understand or bring out some particular mood or theme. For example, an artist can combine certain colors and lines in a painting to produce intense excitement. The same artistic elements can also be combined in a different way to create a feeling of peace and relaxation.

Color is one of the most versatile elements of painting. The Spanish artist Pablo Picasso and the French artist Raoul Dufy used blues to create contrasting moods. Picasso evoked a sense of sadness and loneliness in *The Old Guitarist,* which appears in the **Color** article. Dufy produced a cheerful, airy scene in *Le Haras du Pin,* which appears in the article **Dufy, Raoul.**

Line is one way in which artists build up forms in their paintings. Line also defines space and creates *perspective,* the illusion of depth and distance. Some paintings, such as Chinese landscapes, are composed almost entirely of lines. The Dutch artist Piet Mondrian used lines to define shapes in such abstract paintings as *Composition* (page 80).

Mass allows an artist to express the feeling of weight in a painting. Mass helps the viewers believe they are looking at three-dimensional objects even though the picture is two-dimensional. The German-born artist Richard Lindner created a sense of power and threatening strength by painting the female figure in *Disneyland* with a massive lower body. This painting appears in the article **Lindner, Richard.**

Space is the arrangement of lines and colors to create the impression that the flat surface of a painting is actually a window into a three-dimensional world. An emphasis on empty space in a painting can carry emotional meanings. The American painter Andrew Wyeth created a sense of loneliness and abandonment through the skillful rendering of space in *Teel's Island.* This painting appears in the article **Wyeth, Andrew.**

A painting with a restricted amount of space can establish a closed-in feeling. The Italian artist Jacopo Pontormo created a dramatic, uneasy feeling through the use of confined, distorted space in *Supper at Emmaus.* This painting appears in the **Mannerism** article.

Texture refers to the appearance of the painting's surface. The paint may be thin and smooth or thick and rough. The Dutch artist Vincent van Gogh painted *The Starry Night* (page 39) with thick, swirling brushstrokes to portray a sensation of excitement and agitation.

Composition refers to how elements are arranged in the painting. The artist can choose to compose a flat abstract painting, such as Robert Motherwell's *Elegy to the Spanish Republic LV,* or the artist can create three-dimensional space, as in *Las Meninas* (page 65) by the Spanish painter Diego Velázquez. Composition determines how the painter wants a viewer to "read" a painting. Sometimes the composition emphasizes the most important people or elements by putting them front and center or on a larger scale. The Italian artist Piero della Francesca directed the viewer's attention to the risen Jesus Christ by placing Jesus at the top of a pyramid-shaped composition framed by trees. This painting of the Resurrection appears in the **Easter** article. On the other hand, a painting may be composed to allow the viewer's eye to wander through the picture, as in a Chinese landscape.

Composition can contribute to the mood of a painting. The Canadian artist J. E. H. MacDonald composed his landscape *The Elements* to evoke a feeling of nervous intensity. This painting appears in the **Group of Seven** article. In contrast, the French artist Claude created a feeling of calm order in his landscape *The Father of Psyche Sacrificing at the Temple of Apollo.* This painting appears in the **Classicism** article.



Musée d'Orsay, Paris (Art Resource)

Rouen Cathedral, Full Sunlight by Claude Monet
1895. Oil on canvas.
41 1/8 by 28 3/4 in. (104 by 73 cm).

Light and shade can be used to define form and mass, to direct the eye within the composition, to create space, and to change colors. The French artist Claude Monet created a series of paintings of Rouen Cathedral in France. In this series, the angle and intensity of the light at different times of day determine how the viewer sees the architectural forms of the cathedral. One of these paintings appears on this page.

The Dutch painter Rembrandt skillfully used bright light and deep shadow to establish a tragic mood in *The Descent from the Cross,* which appears in the **Rembrandt** article. Light or its absence can have a symbolic meaning. In *The Oregon Trail* by the American painter Albert Bierstadt, a wagon train travels into a brilliant afternoon sun. The glowing light symbolizes hope for the pioneers. The painting appears in the **Pioneer life in America** article. In Motherwell's *Elegy to the Spanish Republic LV,* the darkness of the abstract forms symbolizes death, while the white background represents life.

Materials and techniques

From prehistoric times to the present day, the painting process has remained basically the same. Artists use powdered color called *pigment* combined with a *binder* that holds the particles of pigment together. The artist may thin the paint, usually with water or turpentine, so it can easily be applied with a brush or brushlike implement onto a *support*. The support is a surface that could range from a prehistoric cave wall to a modern piece of canvas.

The process of painting has not changed over time, but the materials and techniques have changed greatly. Today, artists have many more pigments available to them than they did in ancient times and a much wider variety of binders, thinners, brushes, and supports. Depending upon what choices the artists make among these materials, they can achieve an almost limitless variety of effects.

Pigments. Good painting pigment should be permanent. It must be capable of withstanding normal changes in atmospheric conditions, including light, temperature, and even pollution.

During the Renaissance of the 1400's and 1500's, Italian artists processed iron oxides to produce a range of red, yellow, and brown pigments. They also produced green pigment from copper dioxides. In the late 1800's, artificially produced pigments began to replace the less stable and increasingly rare natural colors. Today, synthetic pigments are the most common color elements in paint.

Binders protect the pigment from changes in atmospheric conditions and serve as an adhesive to anchor the paint to the support. Common binders include vegetable gum arabic and linseed oil.

Different binders have different characteristics. Some dry quickly and others more slowly. Some create an almost transparent paint, while others are *opaque*—that is, they cannot be seen through. The same pigment used in water color, for example, will look different in oil paint because the binder in each possesses different degrees of transparency.

Thinners reduce the *viscosity* (thickness) of a paint so the paint can be more easily applied to the support. Different binders require different thinners. Water is used to thin water color and paints made of synthetic resins. But because oil and water do not mix, water cannot thin oil paint. Instead, painters commonly use turpentine or mineral spirits.

Most thinners are flammable. Many are *toxic* (poisonous), capable of causing minor skin irritations or even permanent damage to the lungs, liver, heart, and brain. Painters should wear goggles and gloves when handling most thinners. Many artists use protective creams under their gloves. The use of thinners requires adequate ventilation. The studio must be cross-ventilated with a minimum of two open windows and an exhaust fan.

Supports. Almost any surface can serve as a support for a painting—a wall; a piece of bark; a panel of wood; or a sheet of fabric, paper, metal, or glass. For much of the history of painting, walls and ceilings were the primary supports. But such surfaces have a basic limitation. The painting, once in place, cannot be moved.

By the 1400's, artists began to paint on supports that were small, light, and portable. They first painted on lightweight wood panels, and later on canvas stretched tightly on a wooden frame. Paper also became an important support. The Chinese, who invented paper more than 2,000 years ago, first painted on it. The material became widely available in Europe in the late 1400's. Paper is fragile, but its porous character makes it the preferred support for water color.

Grounds. Most supports are too absorbent to allow the easy application of paint. Artists usually *prime* (pretreat) a support with one or more coats of a special paintlike material called a *ground*. The only exception is paper for water colors, because the paper's absorbency is right for the paint. Grounds also make the support surface smoother or more uniform in texture. Many grounds, especially white grounds, increase the brightness of the final picture. The three most common grounds are (1) *oil ground*, (2) *glue gesso*, and (3) *polymer gesso*.

Oil ground is made with white pigment, often white lead, in a binder of linseed oil thinned with a small amount of turpentine. After drying, normally in about three days, the oil ground is lightly sanded and a second coat is usually applied. White lead is toxic, so painters should use extreme caution in preparing white lead oil ground. Artists prefer oil ground when they paint on canvas.

Glue gesso is a mixture of white chalk and glue dissolved in hot water. It forms a brittle plasterlike surface that tends to be too stiff for canvas. Glue gesso is used most widely on wooden or wall board panels.

Since the mid-1900's, acrylic gesso has become increasingly popular. It provides a ground of brilliant white that retains flexibility. It does not, however, form a ground suitable for oil painting. Oil paint becomes increasingly brittle with age, while acrylic gesso retains its flexibility. If the two were used together on large oil paintings on fabric, the paint might separate from the ground.

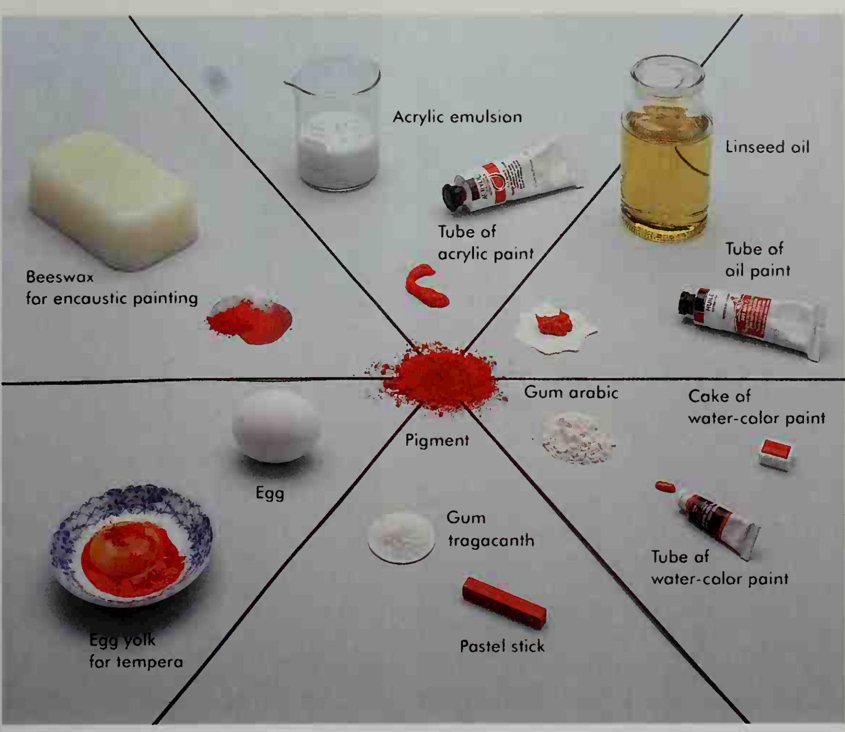
Other materials. When painting with oils or oil-based paint on fabric, the artist must *size* the support before applying the ground. The *size* is a solution of glue, thin enough to penetrate the pores of the support and cover it with a continuous, even film. The size separates the canvas or paper from the oil to protect the support. If oil comes into direct contact with canvas or paper, the support will rot.

Artists apply paint with brushes and painting knives. Brushes come in many sizes and shapes. Bristle brushes are made from the hair running down the spine of a hog from neck to tail. Sable brushes are made from the hair of ermine, martens, and weasels.

Painting knives come in almost as many sizes and shapes as brushes. They are used particularly to apply paint in thick, bold strokes. Areas of thickly applied paint are called *impasto*.

The artist mixes paint on a palette. Almost any flat surface can serve as a palette. Traditionally, palettes have been made of wood, but glass palettes have become increasingly popular because they are easy to clean.

Encaustic painting is made by combining pigment with a hot wax binder—pure beeswax is preferred. Encaustic is one of the oldest techniques in painting. It was



WORLD BOOK photo by Steve Spicer

Artists' paint is made by mixing powdered colors called *pigments* with a substance called a *binder* that holds the particles of pigment together. This picture shows a pigment and some of the most common binders.

WORLD BOOK photo by Ralph Brunke



An artist's materials include paint, thinners, brushes, and knives. This picture shows how an artist might arrange these materials while creating an oil painting. The artist squeezed dabs of color onto a palette. Various sizes of brushes allow the artist to make different kinds of brush-strokes. Knives are used to mix the colors or to apply paint to the canvas.





Saint George and the Dragon by Carlo Crivelli. 1470. Egg tempera on wood 35 ÷ by 18 in. (91 by 46 cm). The Isabella Stewart Gardner Museum, Boston

A Renaissance tempera painting illustrates the detailed images typical of this technique. The full painting, *right,* and detail, *left,* show how artist Carlo Crivelli produced effects of shading through short lines called *hatching.* To make areas darker, he increased the density of the lines.

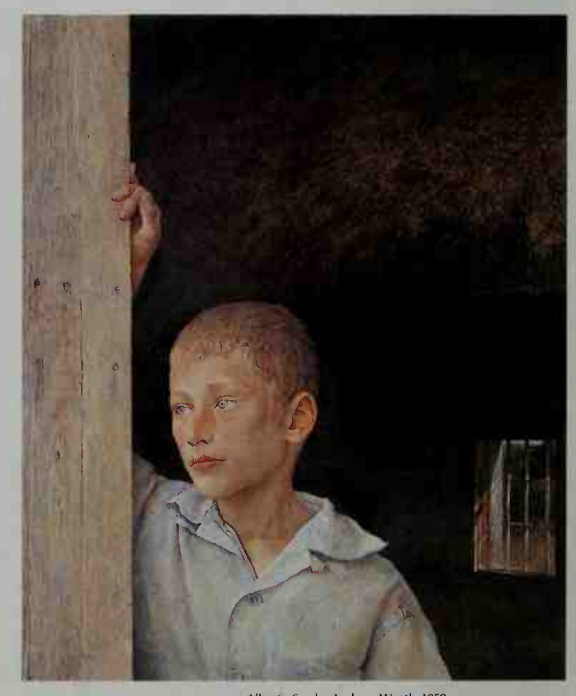
widely used in ancient Greece, though few paintings from that period survive.

The encaustic process is demanding. The artist must work quickly, with short brushstrokes, because molten wax hardens soon after it is removed from heat. Colors are difficult to blend because one will have hardened as the other is prepared. However, some blending is accomplished in a *burning-in* process in which the painted surface is reheated. The brushstrokes can be blended at this point. The burning-in process also allows the wax to stick to its gesso ground.

Although encaustic was virtually abandoned for centuries, the invention of electric heating elements in the 1900's made the technique more practical. Modern painters can use an electric frying pan as a palette and a heat lamp for the burning-in.

Fresco painting is a wallpainting technique. The artist applies pigment to a lime plaster wall. When the paint, mixed with water, is applied to a freshly plastered wall, the process is called *buon fresco* (*good,* or *true, fresco*). When paint is applied to a dry wall that has been moistened, it is called *fresco secco* (*dry fresco*). In buon fresco, the fresh lime plaster absorbs the wet pigment, and the painting becomes part of the wall. In dry fresco, the damp plaster never blends with the paint, which has been mixed with binders such as casein, egg yolk, or glue. Over time, moisture can penetrate between the paint and the wall, causing the paint to crack and peel. See Fresco.

Tempera is a technique in which dry pigment is mixed with a little water to make a paste. Fresh egg yolk



Albert's Son by Andrew Wyeth. 1959.
Egg tempera on Masonite. 29 ÷ by 24 ÷ in. (74 by 62 cm). Nasjonalgalleriet, Oslo, Norway, © Andrew Wyeth

A modern egg tempera painting by Andrew Wyeth expresses a feeling of loneliness. The artist created this feeling by skillfully combining realistic details with areas of light and dark.

is then added equal to the amount of paste. The artist carefully applies the paint with the tip of a fine brush, preferably sable, to a smooth ground prepared with gesso. Tempera dries almost immediately into a water-resistant coating. Because the paint dries so quickly, colors cannot readily be blended. Effects of shading must be accomplished through short lines called *hatching.* The denser the lines, the darker the shaded areas will be.

Tempera painting uses fine, crisp brushstrokes that produce detailed images of extreme clarity and precision. The gesso used as a ground is fully absorbent. When it combines with the tempera, it creates a durable surface that seems to glow. Tempera painting was largely replaced in the 1500's by oil painting. However, several modern artists, including Ben Shahn and Andrew Wyeth, have adopted tempera to take advantage of its characteristic soft, warm light.

Oil painting. Unlike tempera, oil paint can be blended on the painting surface to create a continuous scale of tones and hues. Many shades, especially darker ones, were impossible before the invention of the technique. Using oil paint, the artist can render subtle changes in light and achieve realistic three-dimensional effects. Even more important for the artist, oil paint dries slowly, allowing the artist to work almost endlessly to perfect the image.

Oil paint is made by mixing powdered pigments with a binder of vegetable oil, usually linseed oil. The pigment can be thinned by adding a solvent, such as turpentine. This solution can make thin films of almost transparent color that glaze the painting's surface. The glazing lends a luminous sense of reality to the images.

In oil paint, artists are free to express their personalities through their brush marks. The trail of the brush's path across the painting surface is almost like the artist's autograph. This is especially true when the artist brushes new paint into the undried surface so that it mixes freely with what has previously been painted. The painter's emotions can be detected in the intensity of the brushwork.

Pastel is the painting technique closest to drawing. The artist uses a colored chalk pastel stick. Holding the stick like a pencil, the artist can work rapidly to create broad strokes of color or short, crisp lines.

Pastels are made of pigment held together by a weak, nonliquid adhesive binder such as gum tragacanth. Pastels are labeled *soft, medium,* or *hard,* depending upon how much adhesive is used. Because the pigment is diluted by increased quantities of adhesive, the harder the stick, the less intense its color. Artists seeking brighter colors must work with the fragile softer sticks. Because there is no liquid binder to hold the pigment to its ground, pastel colors rub off easily. To protect the colors, a solution of glue or resin called a *fixative* can be sprayed over the finished picture.

Water-color painting is made by applying pigments suspended in a solution of water and gum arabic to a ground of dampened paper. The paint is transparent. The more water added to the paint, the greater its transparency and the softer its tone. Water color readily spreads through the fibers of the paper, making the edges of the broad painted areas, called *washes,* characteristically soft and fluid. Harder and more precise lines can be achieved by applying relatively undiluted color with a pointed brush, or even by drawing on the



Portrait by an unknown Roman artist. A.D. 100's. Encaustic on wood. 17 ¼ by 7 in. (44 by 18 cm). Museum of Fine Arts, Boston

Encaustic painting is one of the oldest techniques in art. Encaustic combines pigment with a hot wax binder.



Oil painting on canvas (1889). 29 by 36 ¼ in. (74 by 92 cm). The Museum of Modern Art, New York City, Lillie P. Bliss Bequest

Oil painting allows an artist to create a wide range of effects. Vincent van Gogh painted a scene of great emotional intensity in *The Starry Night, above,* by applying oil paint in thick swirls. The result is the artist's highly personal portrait of the eastern night sky.



Detail of a mural (1952-1956, 1966). 14 ft. 8 in. (4.4 m) high. National Museum of History, Chapultepec Castle, Mexico City (Schalkwijk Art Resource)

Synthetic resin painting is a popular technique for murals. The Mexican muralist David Siqueiros pioneered in the development of synthetic resin paints as he sought a durable, easily adaptable paint. His mural *From the Dictatorship of Porfirio Díaz to the Revolution, left,* is a notable example of the artist's experiments with modern synthetic materials.

painting with a pencil or with pen and ink.

Water color is one of the oldest painting techniques, used by ancient Egyptians to illustrate papyrus scrolls. However, artists did not begin to explore the expressive potential of the medium until the 1800's. Artists found that water-color equipment was light and easy to use outdoors, and the paintings dried quickly. As a result, the technique was especially suited to making quick, sketchlike studies of nature.

In one variety of water color, called *gouache,* white pigment or chalk is added. Gouache paintings are characterized by broad, flat areas of color.

Synthetic resins. Starting in the 1930's, painters began to experiment with binders made of synthetic resins. Mexican mural painters pioneered in the development of synthetic resin paints. Painting outdoors, the muralists worked first in fresco and then oil paint, but the sun, rain, and humidity of Mexico jeopardized their works. In 1936, muralist David Siqueiros organized a workshop in New York City specifically to experiment with synthetic paints. One of the first synthetic paints he used was pyroxylin, commonly known as Duco, a lacquer developed as an automobile paint.

By the mid-1950's, researchers in Mexico and the United States had developed a way to mix acrylic resins with water. An artist using acrylic paints can produce works that look almost identical to oil paints. Alternatively, by thinning the paint with water, the artist can create works that resemble water colors. Because there is no chemical reaction between an acrylic resin and its ground, artists can paint with acrylics on unprimed supports.

Acrylic paint can be used on almost any surface. It dries rapidly and is extremely durable. Painters seeking a longer drying time to simulate some of the effects of oil painting add *retarders* to the paint. But even then the paint normally dries within an hour. Because acrylic paints are water-based, they are far less toxic than oil paints and safer to use in closed environments.

Early painting

Prehistoric painting. The earliest paintings date from about 30,000 years ago, during the Paleolithic Period, also known as the Old Stone Age. Prehistoric paintings are found on the walls of caves primarily in France and Spain, but also in Italy and Portugal.

The earliest paintings show animals, human beings, and arrangements of lines and other abstract signs. The artists used earth pigments such as manganese and ochers for red, yellow, and brown; and charcoal for black. They drew directly onto the walls with lumps of these pigments; or they mixed finely ground pigments with water and daubed, brushed, or blew them on. By chance, the pigments, mixing with the moisture in the cave walls, bonded chemically with the limestone to produce the first frescoes.

The most common subjects of cave paintings are large animals—horses, cattle, bison, deer, and mammoths. Many paintings show close observation, with subtle shadings of color, producing a startling realism. Some of the most famous cave paintings were discovered in a cave in Lascaux, France (page 41). For other examples from Lascaux, see the **Horse** and **Prehistoric people** articles.

No one knows exactly why artists painted pictures on cave walls. Scholars agree, however, that cave paintings were not just decorative. Most paintings are in dark and nearly inaccessible parts of caves, difficult places to paint or see the pictures. The art may have served as magical aids in hunting or fertility, as part of initiation rites, or in other ways that were important to early peoples. Between about 8000 and 3000 B.C., during the Neolithic Period, or New Stone Age, artists painted pictures for the first time on the walls of religious chambers or shrines, and on objects, such as pottery.

Egyptian painting. Most Egyptian painting that survives comes from papyrus scrolls and the walls of tombs. The earliest paintings were simple designs, dat-



Off Stonington by John Marin, 1921. Transparent water color. $16\frac{1}{8}$ by $19\frac{1}{4}$ in. (42 by 50 cm). Columbus Museum of Art, Columbus, Ohio. Gift of Ferdinand Howald

A water-color painting is created by applying pigments in a liquid solution onto dampened paper. The water color shown above includes broad transparent areas of paint called *washes.*

ing from about 3000 B.C. During the time of the Old Kingdom (2686 to 2181 B.C.), Egyptian artists normally carved scenes in low relief on tomb walls and then painted the reliefs. The scenes depicted Egyptian deities and daily life. The Egyptians believed these subjects were necessary to ease a person's journey to the land of the dead and to provide for that person in the afterlife.

From the Middle Kingdom (1991 to 1786 B.C.) through the New Kingdom (1570 to 1070 B.C.), artists covered the limestone walls of the tombs with a fine layer of plaster and painted the scenes of deities and daily life directly on the plaster. Painters used few colors, primarily black, red, yellow, brown, blue, and green. They mixed their colors in a binder to make them stick to the dry plaster. By applying the colors thinly or thickly, or by mixing them with black and white pigments, the Egyptian artist could achieve a great range of colors and values.

The Egyptians wanted their tombs and paintings to last for eternity, especially paintings of important people, such as nobles and pharaohs. Artists developed a highly stylized way of showing these important people. They showed each part of the body in its most recognizable form. For example, they drew faces, feet, and legs in profile. They showed the eyes, shoulders, and torso from the front.

Egyptian artists painted figures in flat colors without shading. They used dark red or brown for the flesh of men. They painted women's flesh in yellow, white, or pale brown. This style of coloring can be seen in the painting in the **Hieroglyphics** article.

Nobles and pharaohs sat stiffly or stood solidly on lines representing the ground. Egyptian artists often made members of the nobility larger than other figures in a scene to show their greater importance. The artists portrayed less important people, such as workers, servants, and enemies, in more natural poses and more comfortable movement. For examples, see **Agriculture; Paper; World, History of the** (Early centers of civilization).

The rigid style conventions of Egyptian painting relaxed slightly during the period of the New Kingdom, reflecting the influence of cultures that flourished on Crete and the nearby islands and shores of the Aegean Sea. An example is the more casual pose seen in the tomb painting *Fowling in the Marshes* (page 44). When Egypt came under Roman rule, starting in 31 B.C., portraits of the dead on mummy cases followed the style of Roman painting. Painters posed the bodies in three-quarter view, with the faces nearly frontal. The forms are subtly shaded, using fine strokes of dark and light. However, most tomb paintings from the period of Roman rule followed the style of the period of the Old, Middle, and New Kingdoms. For examples of ancient Egyptian painting, see **Egypt, Ancient** (pictures: Paintings inside tombs); **Heart; Mythology; Osiris.**

Aegean painting. The term *Aegean* is used for the civilization that flourished from about 3000 to 1200 B.C., during the Bronze Age in and near the country now called Greece. This civilization was made up of four cultures. The Minoans inhabited the island of Crete. The Cycladic people lived on islands in the Aegean Sea. The Mycenaean culture, also called the Helladic culture, developed on the Greek mainland. The Trojans lived in the city of Troy in what is now northwest Turkey. Most surviving Aegean painting comes from ceramic vessels and the walls and floors of palaces, villas, and shrines.

Aegean artists painted subjects from nature, including scenes of plants and animals of both land and sea. Many paintings add scenes of religious processions and festivals, along with images of goddesses. Mycenaean and Cycladic painting includes scenes that depict warfare.

The best Aegean wallpaintings come from the palace of Knossos on the island of Crete, but these paintings have survived only in fragments. The most complete Aegean paintings come from the Cycladic island of Thira (also spelled Thera). These paintings show scenes of festivals, animals, battles, sports, and religious ceremonies. One shows a landscape. Many scholars believe that all these paintings had religious significance. An example of a Thira wallpainting appears on page 42.

Aegean art emphasized some of the same conventions used in Egyptian art. For example, Aegean artists



Lascaux Cave, Dordogne, France (Mazonowicz/Art Resource)

Herd of Horses by an unknown artist
About 15,000 B.C.
Horses approximately life-sized.



Detail of a wallpainting from Akrotiri, Thira, National Archaeological Museum, Athens, Greece (Nimatallah/Art Resource)

Ships
by an unknown Cretan artist
Late 1500's B.C. Fresco.
15¾ in. (40 cm) high.

normally painted faces in profile, with a frontal eye. They contrasted the skin of males and females by color. However, Aegean artists applied their colors more thinly and freely than Egyptian artists and more often painted on wet plaster in the true fresco technique. Figures painted by Aegean artists are also more active than Egyptian figures. They move comfortably and are often shown in profile. Figures painted life-sized usually stand close to the front of the picture and are set against a neutral background. However, other figures inhabit complex landscape and architectural settings. Aegean artists indicated distance by placing some figures and buildings higher on the wall.

Greek painting. The earliest Greek painting dates from the 1000's B.C. and is found on vases. Early painters preferred pure ornament, such as lines, circles, and other patterns. They drew figures in black silhouette but based the figures on geometric shapes. The period from about 900 to 700 B.C. is known today as the *geometric style.*

In the 600's B.C., vase painters created scenes from mythology as well as from everyday life. Artists still drew figures in black silhouette. But painters in the city of Corinth cut fine lines into the black silhouette to show detail, and artists in Athens often painted figures in outline to achieve more precise form. Basically, however, artists still showed figures in the old Egyptian style. They painted male figures black, but left female figures in the light color of the clay or painted them white.

About 625 B.C., artists in Athens adopted the *black-figure* technique invented in Corinth in the early 600's. In black-figure painting, the figures are painted in black silhouette. Artists cut details into the surface or added them in red and white. Athenian black-figure vases are the best examples of Greek painting of the 500's. The vases show scenes from Greek mythology as well as simple scenes of daily life that provide some of the most important visual documents of the time. *Achilles and Ajax Playing Checkers* (page 43) by Exekias is an example.

About 530 B.C., Athenian painters invented the *red-figure* style. In red-figure painting, the figures are left in the natural red color of the clay, and details are painted in black with a brush. The red-figure technique freed artists to experiment with a new realism. Almost immediately, artists began to depict figures twisting and turning in space. By the mid-400's B.C., artists were placing figures on different levels of the vase's surface to indicate relative distance. For examples of red-figure painting, see the *dinos* (page 33) and **Furies; Mythology** (Greek mythology); **Odyssey; Oedipus.**

The 400's and 300's marked the great age of Greek wallpainting, but none of these paintings has survived. Artists also painted simple scenes of figures on gravestones and more complex ones on the walls of monumental tombs, especially in the historical region of Macedonia in northern Greece. Superb paintings from the 300's decorated royal tombs in the ancient city of Vergina. The painter placed the action within a landscape setting. The figures are shaded, and almost all are shown in three-quarter view to emphasize the depth of the space in which they act. The artist placed some figures higher on the surface than others in order to further indicate depth.

Etruscan painting. By about 800 B.C., the Etruscans had settled in Etruria, a region in west-central Italy. They imported vases from Greece—especially from Athens—and followed Athenian models for their own black-figure and red-figure vases. The Etruscans also followed these models for the scenes they painted on the walls of their tombs. These tomb paintings show banquets, dancing, sports, and games. Some paintings depict the voyage of the dead to the afterlife. Although their paintings follow the Greek style, Etruscan artists expressed views of their own. They showed subjects, particularly demons, unique to their own religion. By the 200's B.C., some Etruscan tomb paintings showed events in the careers of the deceased, a subject never found in Greek painting. See **Rome, Ancient** (picture: The Etruscan culture).

Roman painting. By the late 100's B.C., Rome had conquered Etruria and Greece, incorporating both regions into the Roman Empire. From these conquered lands, Rome inherited traditions that formed the founda-

tion of its artistic style. The Greeks and Etruscans had limited large-scale painting to public buildings and tombs. However, the Romans used painting primarily to decorate the walls of their houses.

Roman painting is best known from the cities of Pompeii and Herculaneum. Both were buried and preserved by the volcanic eruption of Mount Vesuvius in A.D. 79. Additional Roman paintings have survived from the villas near the mountain. Based on the discoveries at Pompeii and Herculaneum, scholars have generally divided Roman painting into four *Pompeiian* styles based on the decorative scheme of the wallpaintings.

The first style (late 100's to 80 B.C.) featured modeled stucco in relief to imitate large, neatly cut stone blocks. Artists often painted these simulated blocks to imitate colorful marble or other costly stone.

The second style (80 to 15 B.C.) created the illusion of monumental architecture. Artists employed perspective, shading, and shadows to make paintings of columns and other architectural elements that fool the eye with their realism.

The third style (15 B.C. to A.D. 63) rejected the illusion of depth. Instead, artists painted the walls as solid surfaces enlivened with delicate decorative detail.

The fourth style (A.D. 63 to 79) is the best-preserved style. It mixes features of the second and third styles in its real-looking architecture combined with solid areas, rich colors, and decorative detail. An example is *Landscape with Polyphemus and Galatea* (this page) from a villa near Pompeii that was buried in the Vesuvius eruption.

From the second style onward, walls in Roman houses became picture galleries displaying the strong influence of Greek master paintings. In the second style, the wall became the picture itself. In the third and fourth styles, artists painted panels that seem to hang on the walls. Many of these paintings illustrated Greek myths. Others were still lifes and genre scenes.

Roman artists did not merely copy Greek paintings. They reinterpreted them to Roman tastes, often emphasizing landscapes. Artists reduced the size of figures and focused instead on depicting craggy rocks and turbulent seas, delicate foliage, and airy skies. Roman artists also added new subject matter, especially during the second style, when they painted lifelike gardens behind their real-looking architectural scenes.

Roman artists also made technical innovations. They introduced the concept of achieving depth by diminishing the size of figures meant to be farther away. They developed *atmospheric perspective,* the technique of showing distant objects as hazier and more blue in color than objects nearby. After the decline of the Pompeiian styles and until about A.D. 400, portraiture was the predominate subject of Roman painting.



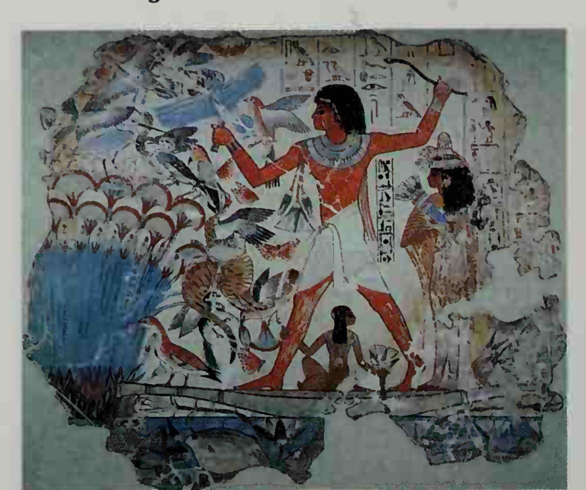
Museo Gregoriano Etrusco, The Vatican Museums, Vatican City (SCALA/Art Resource)

Achilles and Ajax Playing Checkers by Exekias
About 530 B.C. Vase about 24 in. (61 cm) high.



The Metropolitan Museum of Art, New York City, Rogers Fund

Landscape with Polyphemus and Galatea
by an unknown Roman artist
About 11 B.C. Fresco.
$76\frac{1}{4}$ by $50\frac{1}{2}$ in. (194 by 128 cm).



British Museum, London

Fowling in the Marshes by an unknown Egyptian artist
About 1400 B.C. Fresco from the tomb of Nebamun. About 32 in. (81 cm) high.

Asian painting

Asian paintings have been created by many cultures that differ from each other in time, geography, and social values. There are three main artistic traditions in Asian painting. One developed in southern Asia, especially India, but also in Indonesia, Sri Lanka, Nepal, and Tibet. Another tradition emerged in northeast Asia, primarily China, Korea, and Japan. The third comes from the Islamic countries that range from Spain to central Asia and northern Africa.

Indian painting is primarily religious art that deals with themes and beliefs related to the main religions of India—Buddhism, Hinduism, Jainism, and Islam. The earliest paintings in India developed in response to Buddhist needs to communicate religious ideas to the faithful. Paintings of deities and of stories associated with Buddhism covered the walls of temples and monasteries, as well as palaces and mansions.

The great Buddhist cave paintings at Ajanta in western India are the best existing examples of the early wallpaintings. Most of them were painted in the A.D. 400's, during the Gupta dynasty, an era known for great poetry, drama, and dance as well as the visual arts. The paintings provide information on court life as well as religious imagery.

Most Indian painting was later done on palm leaves and still later on paper. This painting dates from the late A.D. 1000's. For the next 700 years, Indian painting was essentially an art of book illustrations, meant to be held and examined at close range. Painters used natural vegetable and mineral pigments and even added parts of insects to their paintings, all according to formulas passed down from master to pupil.

From the time of the Ajanta wallpaintings, Indian painting evolved in a direction that favored flat planes of vivid color, angular movement, and wiry line. By the early 1500's, this style, with large flat areas of bold color and simple compositions, was associated with the Rajput courts of northwestern India. These courts followed the Hindu religion. The painters in the Rajput courts chose stories of gods and mythical heroes for their themes. The life of the god Krishna was popular in every period of Rajput art. Krishna was the ideal child, lover, hero, and religious teacher, as well as the model for masculine behavior.

The ancient Hindu epics the *Mahabharata* and the *Ramayana* were also popular subjects. Another common subject was a collection of Indian musical compositions called *ragas.* Painters transformed poetic descriptions of these musical melodies, each with its own mood, into visual images called *ragamalas* (page 45).

The Muslim Mogul (or Mughal) dynasty conquered India in 1526 and reigned until 1761. Painters working in this dynastic period introduced new subjects—illustrated histories, literary works, and portraits. The scene' *A Ruler on Horseback Leading an Army Across a Battlefield* (page 45), from an illustrated history, reflects a new concern for detail and setting. This concern led to more complex compositions, subtle and varied color, and individual characterizations of figures.

Artists found continuous employment at Mogul courts. Under the Moguls, both Indian and Persian artists created a distinct style of manuscript illustration. The style combined Indian intensity and feeling for nature with Persian technical refinement and European realism. Knowledge of European art came from prints and paintings introduced by merchants and by Jesuit missionaries sent to India to convert the people to Christianity.

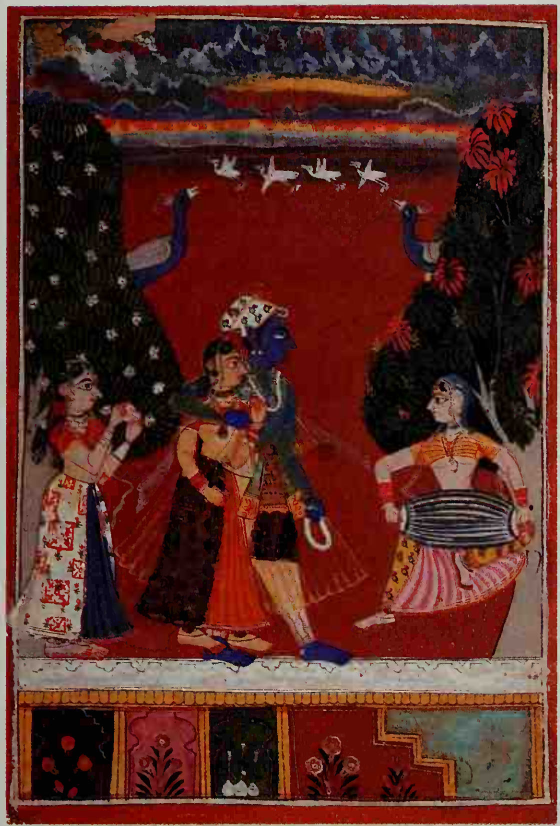
Some Mogul painting turned away from manuscript illustration to the production of individual pictures, such as portraits and studies of animals and flowers. These pictures were mounted in decorated borders and bound in albums.

Chinese painting is closely linked with the older art of writing and evolved directly from it. The Chinese developed beautiful handwriting, called *calligraphy,* as an art form. Chinese artists used the same tools for calligraphy and painting—a flexible brush, a silk or paper support, and an ink stick. The Chinese were writing on silk as early as the 400's B.C. Silk was adopted by painters who liked its smooth surface as early as the 200's B.C. Paper, invented in China, came into wide use for writing and painting by the early A.D. 300's.

The quality of the ink is important in Chinese painting. Artists make ink by mixing oil or soot produced from burned pinewood with glue and then drying it into a stick. This ink produces a lustrous black that, when diluted with water, creates a full range of tones from deep black to pale gray. To make liquid ink, the artist rubs the stick on a stone that has an indentation to hold a small pool of water. Brushes have an absorbent core and a flexible tip that create both flowing strokes and bolder, rugged lines of varying widths.

During the Han dynasty (202 B.C. to A.D. 220), great masters of calligraphy appeared, and writers composed essays devoted to calligraphy as an art form. The craft of beautiful writing was given prestige beyond its usefulness for communicating information. The flexible brush used for calligraphy could transmit the hand movements of the writer, which led to the belief that one could interpret character and personal qualities through calligraphic forms.

Gu Kaizhi was one of the earliest and greatest of the ancient painters. He lived during the Six Dynasties (A.D.



Worcester Art Museum, Worcester, Massachusetts, Alexander H. Bullock Fund

Lovers with Two Attendants (from a *ragamala*) by an unknown Indian artist

1600's. Water color on paper. $9\frac{7}{8}$ by $6\frac{1}{4}$ in. (25 by 16 cm).



Worcester Art Museum, Worcester, Massachusetts, Alexander H. Bullock Fund

A Ruler on Horseback Leading an Army Across a Battlefield by an unknown Islamic artist

About 1594. Water color and gold ink on paper. $18\frac{7}{8}$ by $9\frac{3}{4}$ in. (48 by 25 cm).

220-589). He was famous for painting figures and portraits, but he also painted landscapes. The most famous work attributed to him, but probably a copy, is the hand scroll *Admonitions of the Instructress to the Court Ladies* (page 46). It consists of texts that alternate with illustrations of figures set in a plain background. The painting conveys the character of the early Chinese painting style in the vitality, delicacy, and firmness of the brushstrokes, as well as in the faces that display character and emotion.

Records tell of many great painters who lived during the Tang dynasty (618-907). Tang artists painted portraits, animals, and scenes of court life, but none of their works has survived. Literary sources report that the palaces and temples of the capitals were covered with magnificent wallpaintings. Such paintings in tombs near Xi'an suggest the high quality and dignified character of this Tang art. Cave paintings from western China convey the Buddhist imagery of the period.

The most important development in Chinese painting was the appearance of landscape as an independent subject and not merely as a background for figures and human action. A philosophy called *Neo-Confucianism* was responsible for making nature a proper subject for art. The philosophy flourished during the Five Dynasties and Ten Kingdoms (907-960) and the following Song dynasty. Neo-Confucianism taught that nature is infinite and eternal and can be studied and understood.

The Song (or Sung) dynasty became one of the classic periods of Chinese painting. Historians have divided the dynasty into the Northern Song (960-1127) and Southern Song (1127-1279). Beginning with the Song dynasty, great masters frequently distinguished themselves in both painting and calligraphy. The high esteem given to calligraphy carried over into calligraphic painting.

The earliest surviving Chinese paintings are funeral banners on silk from the 100's B.C. However, the most important Chinese painting formats are the horizontal hand scroll, which is read from right to left; the vertical hanging scroll; and small paintings that served as leaves for albums.

During the Northern Song era, landscape came to dominate painting. Painters used calligraphic brush technique to represent rugged mountains and flowing streams, and also to reflect Chinese attitudes toward the natural world. They worked solely in tones of black ink and used brushstrokes to create mass and texture.

Artists painted large compositions on horizontal hand scrolls and vertical hanging scrolls, such as Fan Kuan's *Travelers Among Mountains and Streams* (page 34). This work is typical of the monumental landscapes of the time that portray an ideal, permanent, and ordered vision of the world. It is carefully organized and filled with complex detail.

Beginning with the Song period, the Chinese distinguished between amateur and professional ideals in painting. Amateurs were scholars or government officials who turned to painting as a means of self-

expression. These painters were not concerned with realism and artistic technique, but with the expression of individual character. Chinese art criticism from the mid-1300's to the early 1900's supported the scholar-painter ideal as the only acceptable one.

The ideal of the scholar-painter became dominant during the Yuan period (1279-1368), a major era in Chinese painting. The art of the Yuan period reached its peak with the work of the "Four Masters"—Huang Kung-wang, Ni Tsan, Wu Chen, and Wang Meng.

Through the influence of the Yuan painters, painting came to function less as an image of nature than as an expression of style. For the amateur painters, the subject, whether it was landscape, bamboo, or an orchid, was a means through which they could reveal their personality. Inscriptions came to play a large role in their paintings. The artists wrote poems on the paintings as a further expression of their feelings. These calligraphic inscriptions formed part of the overall design.

Song painting, especially that of the Southern Song Academy, an art school in Hangzhou, represented the conservative current in Chinese painting. Unlike the extremely personal work of the painters of the Yuan period, Ma Yuan and other masters of the Southern Song Academy expressed a yearning for the simple and the restrained.

Several major painters were associated with the Chan sect of Buddhism, known as Zen in Japan. These painters worked in monasteries near Hangzhou. They painted subtle, refined pictures of great spiritual intensity. The rapid brushwork of the great Chan painter Liang Kai appears in his hanging scroll *Hui Neng, the Sixth Patriarch, Chopping Bamboo at the Moment of Enlightenment* (this page).

The Song artists divided the picture surface into dense and empty areas. They defined rocks and tree trunks by contour lines and texture. They sometimes added light, translucent color. They painted decorative bird and flower pictures in ink and opaque colors. This style was carried to Japan in the 1400's by Buddhist monk-painters such as Sesshu and became the foundation of Japanese ink painting.

The Manchus invaded China in the mid-1600's, taking power and establishing the Qing dynasty (1644-1912). The Manchus looked back to the Yuan period for artistic inspiration. They gave official support and recognition to the *traditionalists,* those painters who carried on the tradition of the Yuan painters. However, the greatest painters of the Qing dynasty were called *individualists* because they could not be classified. The finest Qing painter, Dao-Ji, declared that he had no style and that he studied past masters only to transform them. For examples of Chinese painting, see **China** (The arts); **Wang Wei**.



British Museum, London

Detail from *Admonitions of the Instructress to the Court Ladies* attributed to Gu Kaizhi

A.D. 300's. Ink painting on a paper scroll.



Tokyo National Museum

Hui Neng, the Sixth Patriarch, Chopping Bamboo at the Moment of Enlightenment by Liang Kai

1100's. Ink on paper. $28\frac{5}{8}$ by $12\frac{1}{8}$ in. (73 by 31 cm).

Japanese painting. Japan's long cultural interaction with China affected the entire history of Japanese art. Painting began to flourish with the coming of Buddhism from China and Korea in the mid-500's. During the late 500's and the 600's, Buddhist monks from the Asian mainland brought both painting and artists with highly developed styles and techniques.

The Chinese-inspired style was transformed to more Japanese tastes in Buddhist painting of the Heian period (794-1185), named for the capital of Heiankyo (now Kyoto). Exquisite color and gold leaf enhanced the painting surface, creating an impression of restrained elegance. This style reflected the tastes of the aristocratic culture of the Heian period.

With a rich tradition of forms and materials derived from China, Japanese artists began during the 900's to create works that expressed a truly national artistic experience. This distinctively Japanese-style painting was known as *Yamato-e.* The style used mainly nonreligious subjects, especially landscapes, and was also associated with the Heian court aristocracy. This national style is closely linked to classical Japanese literature and to its poetic response to the changing seasons and the beauty of nature.

Yamato-e hand scrolls also illustrated Japanese tales. These paintings reflect the elegance and refined taste of the Heian court. Painting of the time reached its peak in scrolls narrating *The Tale of Genji* (page 29), a novel by the court lady Murasaki Shikibu in the 1000's. The novel is perhaps the greatest work of Japanese fiction. Professional artists painted the scroll in court workshops. The artists sought to capture the emotion and mood of the novel rather than depict it literally. The paintings have a strong abstract design and a lyrical color sense. For other examples, see **Japan** (History); **World, History of the** (The rise of Japanese civilization).

Both religious and nonreligious narrative hand scrolls flourished in the late Heian period and the Kamakura period (1185-1333), named for its capital, Kamakura. These inventive visual narratives include action tales presented in uninterrupted pictorial sequences.

A new style of painting arrived from Song and Yuan China in the late Kamakura period in the form of *monochrome* (single color) ink paintings. This style was brought to Japan by Chinese monks coming to work in Japanese Buddhist monasteries. In addition to ink painting, the monks introduced Song *polychrome* (multicolored) realistic portraits into Japan.

Monochrome ink painting dominated Japanese painting well into the 1500's. Early Japanese monk-artists depicted the founders of their faith as well as animals and plants, such as the tiger and the orchid, which had symbolic meanings. The painters' colleagues and friends often inscribed poems in the Chinese style on the upper part of the paintings.

Ink paintings became a truly Japanese form with the work of two monk-painters of the 1400's—Tensho Shubun and his pupil Sesshu. After traveling to Korea in 1423, Shubun introduced a more sweeping landscape style. He painted on screens and scrolls, using ink washes and fine black lines. Sesshu traveled to China in 1467, where he came into contact with classical Ming painting. On his return in 1469, he worked in a variety of styles and techniques, a diversity shared by many later



Tokyo National Museum

Detail from *Cypress* by Kano Eitoku
Late 1500's.
Ink painting with gold leaf on paper. 6 by 16 ft. (1.83 by 4.88 m).

Japanese painters. Sesshu created technically superb and powerful compositions in both ink and color. After Sesshu, ink painting emerged as a nonreligious style no longer associated with the Buddhist community.

The Kano school, founded by Kano Masanobu in the late 1400's, became one of the most powerful artistic groups in Japanese art for centuries. Kano Motonobu, his son, was the school's principal teacher. Kano school artists painted traditional Chinese themes in a style of balanced composition and sharply defined line. Beginning in the 1500's, Kano paintings included Japanese subjects depicted in color. Motonobu's grandson Kano Eitoku created a new style in which he reduced forms to bold and simplified shapes that could be understood at a glance. In paintings such as *Cypress* (this page), Eitoku created a new style. He departed from the previous Kano emphasis on delicate, single-colored paintings. Instead, he painted large works in a flat, bold-patterned style using gold leaf and color. He painted *Cypress* on the large surface of an eight-panel folding screen. His new monumental style glorified the power of his patrons, who were military warlords.

An artistically rich period emerged during the Edo era (1603-1867), named for Edo (now Tokyo), the political center of Japan. This period is also called the *Tokugawa,* after the name of the ruling dynasty of *shoguns* (generals). Artists drew on various traditions—Japanese, Chinese, and Western. This interaction of traditions gave artists access to a large artistic vocabulary. The Kano school continued to prosper as the official painters of the Tokugawa shoguns. The basic style of Edo painting came from the Kano school together with that of the Tosa school, which took its subjects and techniques from classical Yamato-e. The later Edo period also produced realistic landscapes painted in color.



Worcester Art Museum, Worcester, Massachusetts, Jerome Wheelock Fund
Bahram Gur Hunting the Wild Ass by an unknown Persian artist
About 1335. Water color on paper.
24 by 16 $\frac{1}{8}$ in. (61 by 41 cm).

The building projects of the shoguns were important training grounds for painters and craftworkers and provided many opportunities for professional artists. Artists painted screens and other works that decorated the new buildings. The growth of castle towns enhanced patronage for regional painting styles. The aristocracy living in Kyoto was the official patron of Tosa school painting, but wealthy merchants also supported it.

In the early 1700's, the growing middle class provided new patrons whose tastes ran from elegant and refined paintings to simple folkish art. This period is more familiar to the Western world through the multicolored woodblock prints called *ukiyo-e* (pictures of the floating world). Ukiyo-e depicted the theater and other urban amusements. The Japanese referred to these passing scenes of city life as the "floating world."

Islamic painting is art associated with the religion of Islam, first preached by Muhammad in the A.D. 600's in what is now Saudi Arabia. Calligraphy is the supreme art in the Islamic civilization because the Islamic holy book called the Koran was written in the beautiful script of the Arabic language. Muslims believed that calligraphy carries the divine message of the Quran in the form of the writing as well as in the meaning of the words.

Islamic art reflects a complex attitude toward the representation of living forms. Islam prohibits the depiction of animal and human forms in all art related to the religion. As a result, religious art often combined calligraphy with floral or geometric designs. However, Muslim princes inherited a liking for paintings of human beings and animals from the cultures that Islam had conquered. Throughout the history of Islam, privately owned nonreligious paintings include lifelike images.

The best-known Islamic paintings are book illustrations. Many of these paintings illustrate classics of the literature of Persia (now Iran), beginning in the 1200's. One popular subject for painters was the *Shah-Namah (Book of Kings).* This long work was written by the poet Firdausi and completed about 1010. The *Shah-Namah* ranks as the national epic of Persia, consisting of episodes from Persian history mingled with myths and legends. An illustration from the epic called *Bahram Gur Hunting the Wild Ass* (this page) was painted by an artist in the city of Tabriz. His painting shows the exquisite drawing and jewellike color that characterizes much of Islamic painting.

Medieval painting

Historical background. The Middle Ages began in the A.D. 300's, during the last years of the Roman Empire, and ended with the emergence of modern nations in the 1400's. The Middle Ages overlapped with the early years of the Renaissance in Italy.

During the Middle Ages, Europe was divided into small territories controlled by a military aristocracy. The economy was based on agriculture, and most people lived in self-sufficient villages. Gradually, territories were organized into larger units under a system called *feudalism.* Under feudalism, landowning nobles gave other nobles the use of land in exchange for their allegiance. Eventually, powerful families established kingdoms and ruling dynasties. Trade increased, craftworkers organized into guilds, and villages grew into towns.

The Christian church replaced the Roman Empire as the dominant organization in Europe. The most powerful political and religious leader in the West was the pope. The Byzantine Empire controlled much of the East, and Eastern Christians belonged to one of the Eastern Orthodox Churches. Muslims eventually controlled the Near East, north Africa, and southern Spain.

Former Roman provinces became dioceses of the church. Monasteries and convents served not only as religious institutions but also as hospitals, schools, and cultural centers. For centuries, monks and nuns created the finest medieval art and architecture.

Most people during the Middle Ages lived in relatively isolated communities. The Christian church, however, remained an international organization ruled by the pope from his headquarters in Rome. The church encouraged people to travel, either on religious pilgrimages to the shrines of saints or by joining a Crusade. The Crusades were a series of military expeditions from 1096 to 1270 to take Jerusalem and Christian holy places in Palestine from the Muslims. Crusaders and pilgrims brought new ideas and art back with them. Medieval art reflects the contrast between regionalism, which consisted of local styles and techniques, and internationalism, which reflected a wider knowledge and view of the world.

Artists worked for the church or for royal and noble families. Most of the art made for aristocrats has been destroyed. Because art was preserved in the churches, most medieval painting that survives is religious art.

Church leaders were conservative in their taste in painting. Artists were required to make good reworkings of earlier art, not create something new. Originality and individuality in art were not considered important, and few artists even signed their work. Thus, artistic change came slowly.

Medieval paintings were either small or very large. The small paintings included *illuminated* (decorated) manuscripts along with images of Christ and the saints known as *icons.* Most large paintings were murals. Painters also designed tapestries and mosaics that decorated walls.

Early Christian and Byzantine art. In the 300's, Christianity became the official religion of the Roman Empire. Eventually, Christianity divided into two main branches, the Western church in Western Europe and the Eastern Orthodox Churches in the East.

The earliest Christian art in the West can be seen in the catacombs, which were burial chambers in Rome. The early Christians painted symbols of their faith, images of Christ, and stories from the Bible on the catacomb walls. After Christianity became the official religion of the empire, Christian artists continued to decorate the walls of funeral chapels with paintings as well as mosaics. For an example of catacomb painting, see **Bible** (picture: Scenes from Biblical stories).

The art made for the Eastern Orthodox Churches is called *Byzantine art* after Byzantium, the original Greek name of Constantinople (now Istanbul, Turkey), the capital of the Roman and then of the Byzantine empires. Byzantine artists painted murals and richly colored illuminated manuscripts as well as icons.

Worshipers were taught to *venerate* (show deep respect for) icons and looked at them when they prayed. The icon *Virgin and Child Enthroned with Angels and Saints* (this page) shows Mary holding the infant Jesus on her lap. The warriors Saint Theodore and Saint George stand guard as two angels look toward heaven. The Christ child and the angels are portrayed in an almost realistic style. The saints and the Virgin are flat and stylized. The warriors stare ahead with wide open eyes. Their bodies disappear under their patterned silk cloaks. Mary becomes a throne for her child rather than a living mother. For more information on Byzantine painting, see **Byzantine art**. For additional examples of Byzantine painting, see **Icon** and **Russia** (The arts).

Early medieval painting in the West. From the 300's to the 1000's, Western European art flourished in important and wealthy monasteries. Missionaries carried illuminated Gospels and other Christian art to new territories, spreading painting styles from place to place.

In the British Isles, Celtic and Anglo-Saxon monks made some of the most beautiful books ever created, notably the *Book of Kells.* This work is a *Gospel book*—that is, a book containing the four Gospels. Celtic artists decorated pages of the *Book of Kells* with complex combinations of letters, spirals, animals, and sometimes highly stylized human figures. The drawings are filled with bright, clear colors that make the page resemble a piece of enameled goldwork or an intricately woven carpet. For an illumination from this book, see **Manuscript**.

About the year 800, the great leader Charlemagne united much of Western Europe. He sponsored an edu-



Santa Katerina Monastery, Mount Sinai, Egypt (Erich Lessing, Art Resource)

Virgin and Child Enthroned with Angels and Saints by an unknown Byzantine artist

Early 600's. Encaustic on wood. 27 by 19 $\frac{1}{8}$ in. (69 by 49 cm).



Bibliothèque Municipale, Épernay, France (Giraudon/Art Resource)

Saint Matthew (from the *Gospel Book of Archbishop Ebbo*) by an unknown medieval artist

About 815-835. Illuminated manuscript. 10 $\frac{1}{4}$ by 8 $\frac{3}{4}$ in. (26 by 22 cm).



Bibliothèque Nationale, Paris (facsimile from the Newberry Library, Chicago)

Abraham and the Three Angels (from the *Psalter of Saint Louis*) by an unknown French artist

About 1250-1270. Illuminated manuscript. 5 by 3 ½ in. (13 by 9 cm).

cational and cultural program as well as political and economic reforms. He understood the importance of education and set up schools and *scriptoria* (writing rooms in monasteries) throughout his empire. The art created in Charlemagne's empire is called *Carolingian.* The richness and variety of Carolingian art are reflected in the illuminated books made especially for the churches and monasteries that Charlemagne established.

An example of Carolingian illumination is the Gospel book made for Archbishop Ebbo in a monastery near Reims, France (page 49). The illumination shows Saint Matthew, one of the Gospel writers, seated on a large red cushion with his feet on a footstool. He leans on his desk as he writes with a quill pen and holds a horn filled with ink. He is inspired by an angel, who appears in the upper right corner. The landscape, Matthew's togalike robe, and his furniture are copied from early Christian art. The artist used a fine brush to create a picture that looks almost like a pen drawing. The lines have so much energy and movement that they suggest the saint is caught up by intense religious feeling and the importance of his work. His hair is wild, and his clothes and body are twisted. Such linear energy resembles the complicated geometry of Celtic painting.

Romanesque painting flourished in Western Europe beginning about 1050. This art is not Romanlike, as the name suggests. The name was given to the style in the 1800's by historians who related the architecture of that period to the round arches found in Roman buildings.

During Romanesque times, wealthy monasteries became the most important patrons of the arts. Many churches were built, and old buildings were enlarged and redecorated. Mural paintings became important.

The wall behind the altar at the Church of San Clemente of Tahull in Spain was painted with a huge figure of *Christ of the Apocalypse* (page 51). He sits on a rainbow with His feet on the world, holding an open book inscribed "I am the light of the world." He raises His right hand in blessing. Around Christ, fitting the curve of the wall, are the four authors of the Gospels. They hold their books and the animals that symbolize them. Paintings of the Virgin Mary and the apostles appear on the wall below Christ.

The San Clemente artists did not try to make the figures look like living people. Instead, they followed the traditional way of representing the images. The different sizes of the figures established an order in which Christ, the most important figure, is the largest. All the figures are flat and stylized. They have heavy dark outlines, simple geometric shapes, and bright colors that would be easy to see even in a dark church lit by candles. For another example of Romanesque painting, see **Bible** (picture: Saint Jerome).

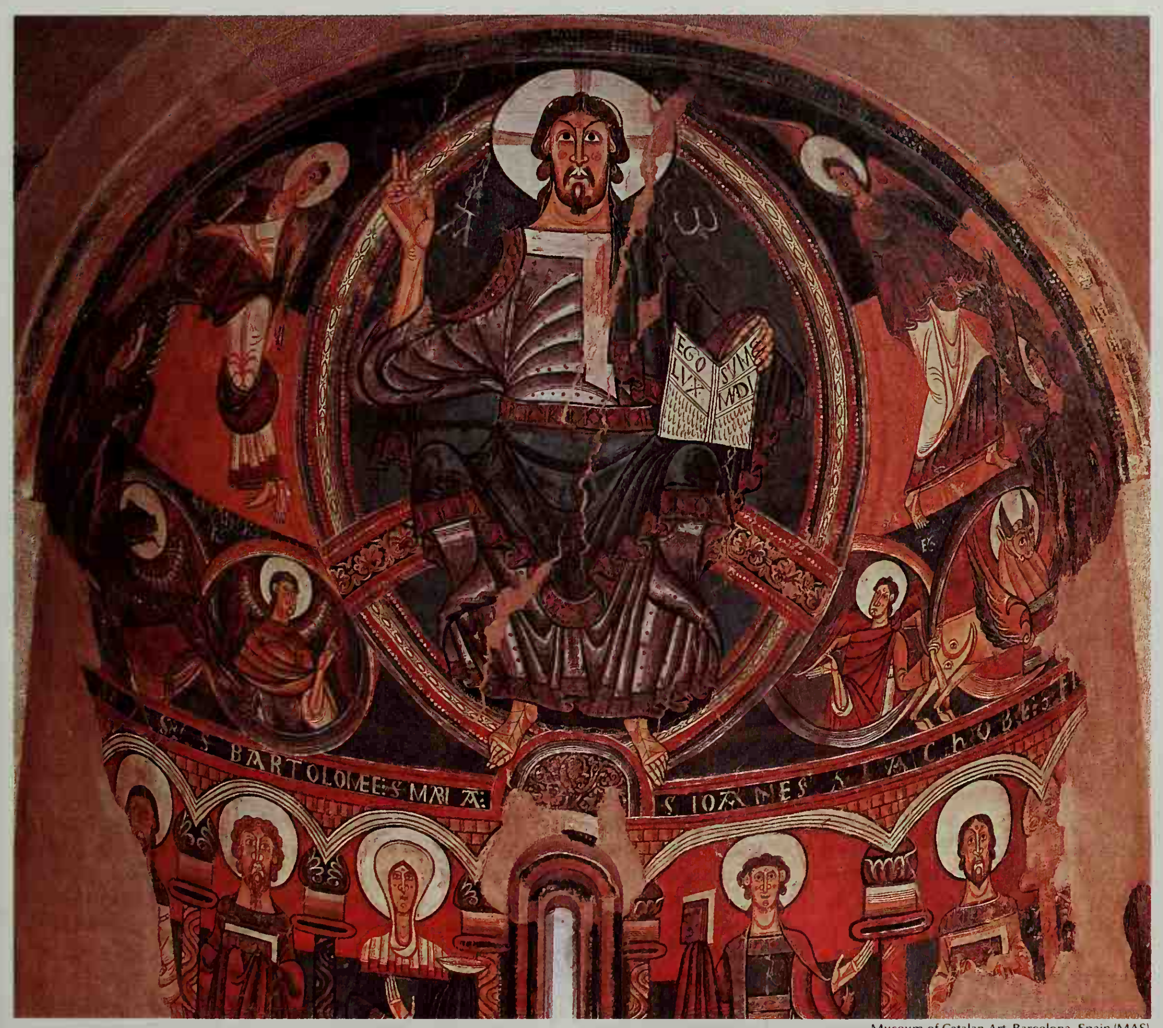
Gothic painting. The Gothic period lasted from about 1150 to about 1400. Kings gained control over feudal lords and established nations. Cities with merchants and craft guilds became more important than agricultural villages. Universities replaced monasteries as centers of learning and culture. Professional painters and scribes, not monks and nuns, painted illuminations.

Gothic painters looked at all of the world, not just human beings. At first, they studied the details of nature, including leaves, flowers, animals, and insects. Gradually, they painted human beings acting out stories that suggest the natural world.

In the illumination *Abraham and the Three Angels* (this page), the Biblical patriarch Abraham meets three young men, who are angels, under an oak tree. He invites them home and gives them food. The painting shows Abraham and the angels twice. First, they meet on the left side of the painting. Then, on the right, Abraham kneels in front of the table as his wife, Sarah, stands in the doorway of their home. To Christians, the three angels symbolized the Trinity as well as the Biblical story of Abraham and Sarah's generosity.

The figures in the illumination look more like real people than Romanesque figures, but they are still stylized. The figures are tall and slender and stand in elegant poses. Their faces are idealized. Although they gesture vigorously, their graceful bodies seem to disappear under the elegant drapery patterns. Their long fingers seem too delicate to grasp anything, and the figures appear to take up no space against the gold background. Even the table with the dishes and food becomes a flat pattern. Yet the artist has begun to look at the world around him. The oak tree has an important position in the center of the painting, and its leaves and acorns are carefully shown. The architecture that frames the scenes is copied from a real building, La Sainte Chapelle in Paris.

Some Gothic artists painted on a large scale, making



Museum of Catalan Art, Barcelona, Spain (MAS)

Christ of the Apocalypse by an unknown Spanish artist
1100's. Fresco. Main figure larger than life-sized.

pictures called *cartoons* for weavers to copy for tapestries that covered church and castle walls. Artists also painted huge stained glass windows.

Especially beautiful illuminated books were created in the late 1300's and early 1400's for the Duc de Berry, a brother of the French king, Charles V. The duke collected manuscripts and employed a number of painters, the most famous being the three Limbourg brothers, Pol, Herman, and Jean. For examples of their greatest work, *Très Riches Heures (Very Rich Hours),* see **Europe** (picture: During the Middle Ages); **Middle Ages; World, History of the** (The world from 500 to 1500). For other examples of illuminated manuscripts, see **Gothic art; Illuminated manuscript.**

The Renaissance

The Renaissance was a great cultural movement that began in Italy in the early 1300's and spread to other European countries. The word *Renaissance* comes from a Latin word meaning *rebirth.* What was actually reborn during the Renaissance was an interest in *classical antiquity,* the culture of ancient Greece and Rome.

The 1300's. By the 1300's, such Italian writers as Giovanni Boccaccio, Dante Alighieri, and Petrarch were studying Roman literature and the world around them. They began a movement called *humanism,* which stresses the importance of human beings (see **Humanism**). Humanism had a profound influence on painting. Painters began to look with new interest at the art of ancient Greece and Rome and at their fellow human beings.

The change from medieval to Renaissance painting can be traced in the styles of Giovanni Cimabue and his pupil Giotto. A detail of Cimabue's *Madonna Enthroned with Angels* appears in the **Renaissance** article. A comparison of that painting with Giotto's *Madonna Enthroned with Saints* shows the difference between Cimabue's late medieval style and Giotto's style, which was a forerunner of Renaissance painting.

Cimabue's painting achieves an otherworldly appear-



Scrovegni, or Arena, Chapel, Padua, Italy (SCALA/Art Resource)

Joachim with the Shepherds (also known as *Joachim Takes Refuge in the Wilderness*) by Giotto
About 1305. Fresco. 6 ft. 5 in. by 6 ft. 10 in. (1.96 by 2.08 m).

ance. The artist placed an abstract network of gold lines on the Madonna. The lines seem to make the figure flatter and almost transparent, as if the gold were shining through her. Giotto's composition occupies a more natural physical space. He used white highlights on Mary's lap and chest to suggest physical bulk and presence. Giotto's concern with solid forms and real space demonstrates an interest in the natural world that was strikingly different from the formulas of medieval painting.

Giotto was one of the most remarkable painters in art history. Giotto's subjects were Biblical stories and the lives of saints, but he was interested in how people looked and acted. His work indicated a change from symbolic art of the Middle Ages, which concentrated on religious ideas, to the more humanistic art of the Renaissance.

As Giotto studied people, he copied their gestures and expressions in paintings like *Joachim with the Shepherds* (this page). The scene is also known as *Joachim Takes Refuge in the Wilderness.* Joachim is downcast because he and his wife, Saint Anne, have no children. The shepherds seem worried and curious. A dog jumps up to greet a stranger, an angel who will announce to Joachim that his wife will become the mother of the Virgin Mary. Giotto painted the shepherds' hut and the rocks and trees of the landscape in three-dimensional forms, not the flat medieval style. He even painted blue sky instead of the gold background that Gothic painters used. Giotto emphasized the human characteristics of his figures, portraying the weight of their bodies under heavy drapery by modeling in light and shade. For more examples of Giotto's painting, see **Christianity; Jesus Christ** (picture: Jesus's childhood).

As artists became more highly trained in painting techniques and the ideas of humanism, they altered their styles. There was a greater demand for realistic images. Artists made discoveries that led to new ways of portraying the human form, pictorial space, color, gestures, and the placement of figures. For example, Renaissance painters rediscovered the rules of *linear perspective,* a mathematical system for showing depth on a flat surface. The technique had been largely abandoned during the Middle Ages.

The center of early Renaissance painting was the city of Florence. In 1348, a terrible outbreak of plague called the *Black Death* killed many Florentines. Only a few artists in the city survived. The destruction caused by the plague reduced interest in the arts and inhibited developments in painting initiated by Giotto. As a result, further developments in Renaissance painting did not occur until the 1400's.

The 1400's in Renaissance art history are sometimes called the *Quattrocento,* an Italian word that means *four hundred.* This century was a period of intense political,



Santa Maria del Carmine Church, Florence, Italy (SCALA/Art Resource)

The Tribute Money by Masaccio
About 1427. Fresco. 8 ft. 4 $\frac{1}{8}$ in. by 19 ft. 7 $\frac{1}{4}$ in. (2.55 by 5.99 m).



San Marco Museum, Florence, Italy (SCALA/Art Resource)

The Annunciation
by Fra Angelico
About 1450. Fresco.
7 ft. 6 1/2 in. by 10 ft. 6 1/8 in.
(2.30 by 3.21 m).

economic, military, religious, and artistic activity.

An early masterpiece of the Quattrocento is Masaccio's *The Tribute Money* (page 52), a fresco painted in a church in Florence. In the painting, Masaccio demonstrated many of the stylistic innovations that characterized Renaissance painting. These innovations included linear perspective, anatomical accuracy, and evenly spaced figures.

Masaccio's fresco tells a story from the Bible. Jesus and His disciples have gathered near a town controlled by the Romans. A Roman official demands that the group pay the tax necessary to enter the town. Although the disciples protest, Jesus orders Peter to look in the mouth of a fish, on the left, where the disciple finds the money to pay the tax collector, on the right. The perspective establishes a horizon line at about the level of the heads of the grouped figures, with Jesus in the middle. The poses of the bodies follow the laws governing human anatomy, and the gestures are simple and clear.

Fra Angelico worked about the same time as Masaccio, but in a simpler style, as in his fresco *The Annunciation* (this page), painted in a convent in Florence. Fra Angelico understood perspective and used it in his painting, but he did not follow Masaccio's interest in anatomical accuracy and forceful gestures. The Madonna sits modestly as she hears the Angel Gabriel announce that she will become the mother of Jesus. Gabriel kneels in a position that shows great respect. The angel appears quiet and devoted, and his clothing falls in neat, simple folds.

In northern Italy, Andrea Mantegna produced masterworks of Renaissance art. Mantegna learned much from the Renaissance sculptor Donatello, who revived classical ideas of physical beauty by sculpting the first large nude figures since ancient times. Mantegna also studied the ancient ruins of Italy. In *Saint Sebastian* (page 54), Mantegna revealed his interest in anatomy, the ideal figure, and antiquity. Sebastian was an early Christian saint. After the Romans discovered he was a member of the outlawed Christian faith, they shot him with arrows. Mantegna may have chosen Sebastian as a subject because it gave him the opportunity to portray an ideal human figure bound to a classical ruined arch. The painting's realistic anatomical detail and the heroic character of Saint Sebastian make it typical of the interest in nature and humanism popular in Italy.

Sandro Botticelli absorbed the technical accomplishments of earlier Renaissance artists and added a personal poetic style. Botticelli cared less about realism than he did about decorative effects. His *Birth of Venus* (page 54) shows Venus, the Roman goddess of love and beauty. She has just arrived on shore, blown there by gods of the wind called Zephyrs, on the left. Venus is attended by another mythological deity called an Hour, on the right, who is about to cloak Venus's naked beauty. The painting has a fine delicacy created by the emphasis on V-shaped waves and flowing clothing and hair. The figure of Venus stands in a curved, almost unnatural pose. The result is a painting less realistic than was common for the period.

In contrast to Botticelli, Leonardo da Vinci almost never experimented with decorative or ornamental effects. Instead, he concentrated on what he thought was a scientific and rational approach to art. At the same time, he was interested in conveying feelings with his art.

Leonardo's *Madonna of the Rocks* (page 55) represents Jesus and John the Baptist as infants, the Virgin Mary, and an angel in a dark landscape. Leonardo's understanding of the human body and his interest in new lighting effects appear in the painting. Unlike Masaccio and Mantegna, Leonardo did not put his figures in a clear atmosphere so the viewer could see all the details of the human forms. Instead, he blurred and darkened his outlines with shades of color in a technique called *sfumato* (smoky). The sfumato submerges the figures and landscape in shadows that help create a peaceful mood. The dusky light reveals the protectiveness of

Mary, the sweetness of the children, and the gentle gracefulness of the pointing angel. The arrangement of the figures in a pyramid is typical of many Renaissance paintings and adds to the painting's sense of stability and calm.

The High Renaissance is the term given to the years from about 1500 to 1525 in Italian painting. This period reached its peak through the powerful patronage of Pope Julius II and the work of such artists as Michelangelo and Raphael.

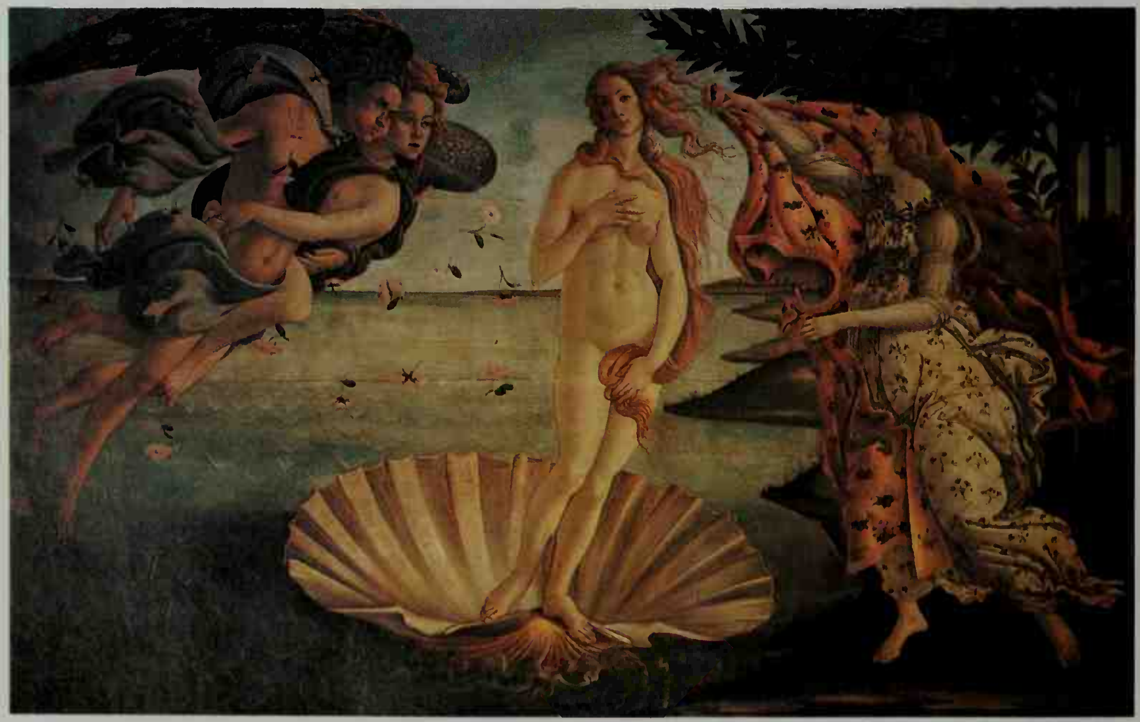
Painters of the High Renaissance continued and even emphasized elements of earlier Renaissance art. These elements included the realistic treatment of space, an understanding of the human body, the clear use of colors, and formal compositions. But differences did emerge. Figures in High Renaissance paintings have a strong presence not often seen earlier. Figures portrayed as stiff and immobile in the works of the 1400's were shown twisting and spiraling in space. Artists stressed anatomy. Gestures became broader, and facial expressions stronger and more commanding. Compositions that had been shallow grew deeper, and painters tried to make the space more convincing.

Michelangelo. Among the early masterpieces of the High Renaissance were Michelangelo's frescoes for the Sistine Chapel commissioned by Pope Julius II. The chapel is next to St. Peter's Basilica in Rome. The pope considers the Sistine Chapel his own private chapel. In addition, the Sacred College of Cardinals meets there to elect new popes. Michelangelo worked over a period of about four years on the ceiling frescoes. He chose



Kunsthistorisches Museum, Vienna, Austria (Erich Lessing, Art Resource)

Saint Sebastian by Andrea Mantegna
About 1460. Tempera on wood.
26 $\frac{3}{4}$ by 11 $\frac{7}{8}$ in. (68 by 30 cm).



Uffizi Gallery, Florence, Italy (SCALA Art Resource)

Birth of Venus by Sandro Botticelli
About 1485. Egg tempera on canvas. 5 ft. 7 $\frac{1}{4}$ in. by 8 ft. 11 in. (1.72 by 2.72 m).



The Louvre, Paris (Erich Lessing, Art Resource)

Madonna of the Rocks by Leonardo da Vinci
About 1483. Oil on canvas. 6 ft. 6 $\frac{1}{4}$ in. by 4 ft. (2.00 by 1.22 m).



Uffizi Gallery, Florence, Italy (Art Resource)

Madonna of the Goldfinch by Raphael
1506. Oil on wood. 42 by 30 $\frac{1}{4}$ in. (107 by 77 cm).

scenes from the Book of Genesis that illustrate events from the Creation to Noah and the Flood.

Michelangelo's fresco *The Creation of Adam* (page 56) from the chapel ceiling is characteristic of Renaissance humanist attitudes. In the painting, God, portrayed as an elderly man, hurtles with great force and speed toward the passive, awakening Adam. Adam is already alive, even before God touches his finger. The creation about to occur may be the birth of human potential, the enabling of Adam to choose whether to ascend to greatness or decline into sin.

Michelangelo's figures are strongly three-dimensional, well muscled, and anatomically accurate. Adam is already physically perfect, an ideal male nude. Michelangelo's powerful rendering of the human form enhances a quality called *terribilità* (awesomeness), for which the artist became noted. The "awesomeness" refers to the barely contained energy of the figures. For other examples of Michelangelo's painting, see **Michelangelo.** See also **David; Isaiah, Book of; Jeremiah, Book of; New Testament; Religion** (A doctrine of salvation); **Sistine Chapel.**

Raphael. While Michelangelo was working on the Sistine Chapel, Raphael was painting the *School of Athens* in a nearby room in the Vatican. The painting appears in the **Raphael** article. Many historians see the *School of Athens* painting as the fundamental expression of the High Renaissance. It shows the ancient Greek philosophers Plato and Aristotle acting out their individual philosophies. Plato, pointing upward, represents the tradition of philosophy concerned more with ideas than with particulars, which finds its truth descending from above. Aristotle gestures outward to indicate his reliance upon evidence that can be found in the real world. Arranged near Aristotle are the scientists and mathematicians of earlier ages. To Plato's right are philosophers, who draw conclusions from logical assumptions and pure reason rather than actual experience.

Raphael arranged the figures in the *School of Athens* in a deep circle. The lighting is clear and even. The space is generous and rational. The figures are evenly spaced. Everything is calm, centered, logical, and visually understandable.

Raphael achieved a more intimate grace with his *Madonna of the Goldfinch* (this page). Mary sits calmly with the Christ child and His cousin John the Baptist. Raphael placed this tranquil family in a peaceful landscape of clearly outlined forms that represents the Renaissance ideal of harmony and balance. For other examples of Raphael's painting, see **Europe** (The arts); **Plato; Raphael; Renaissance** (The Italian Renaissance).

The Renaissance in Venice. The Renaissance painters of Rome and Florence were concerned with telling stories and portraying religious scenes. The painters of



Academy of Fine Arts, Venice, Italy (SCALA/Art Resource)

The Tempest by Giorgione
About 1505. Oil on canvas.
$30\frac{5}{8}$ by $28\frac{3}{8}$ in. (78 by 72 cm).

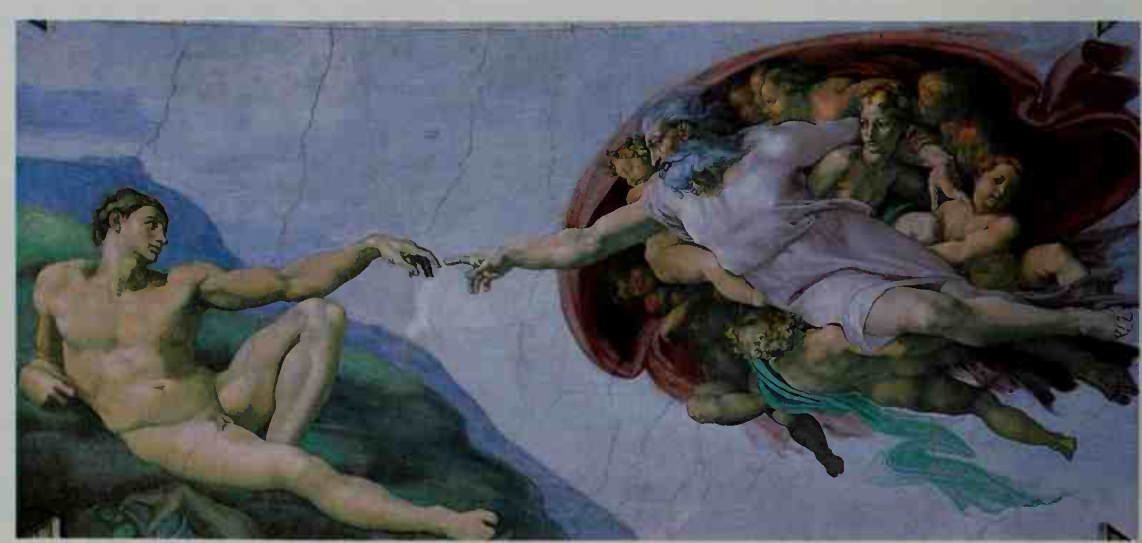
Venice stressed a poetic mood and the mystery of nature. Giorgione's *The Tempest* (this page) depicts a dramatic landscape. In *The Tempest,* the colors of the vegetation are rich and deeply green. A storm dominates the center of the composition. Historians do not agree on the meaning of this painting. It may simply be an expressive scene of a young woman nursing a child while a man stands nearby.

Sebastiano del Piombo was a Venetian painter whose early works were strongly influenced by Giorgione's style. However, Sebastiano gained his greatest fame after moving to Rome in 1511. The finest paintings of his Roman years are portraits, notably *Portrait of Pope Clement VII* (page 57). Sebastiano painted the pope as a man of grave and compassionate appearance and character. The pope, a member of the powerful Medici family in Florence, was a patron of such artists as Michelangelo and Raphael.

Venetian artists loved color. Titian's *Crowning with Thorns* (page 58) shows a traditional religious scene, Jesus being tormented by Roman soldiers as they push a crown of thorns on His head with long poles. Titian's painting is troubling and emotional. The scene portrays great suffering and passion. Titian evoked emotion by setting the figures in a darkly lit passage. He painted the figures loosely, brushing on bold strokes of color, so the figures have an incomplete, nightmarish quality. By blurring the edges and using rich, dark colors, the artist created a vague and threatening feeling.

Paolo Veronese used the coloristic tradition of Venice to paint scenes of spectacular beauty. His enormous painting *Feast in the House of Levi* (page 59) was originally condemned by church officials who thought it was a painting of the Last Supper. The officials complained about the presence of "buffoons, drunkards, dwarfs, Germans, and similar vulgarities" at the final meal shared by Christ and His disciples. Veronese then changed the painting's title to reflect an episode in which Jesus brought His message to sinners. Whatever the actual subject of the work, it portrays an exuberant, festive joy of life. The setting is magnificent, the scale huge, and the background typical of Venice in the 1500's. All the figures, including the dog and cat, enhance the atmosphere of color and delight.

Mannerism is the name given to a new style that emerged about 1520 in central Italy. The term *mannerism* comes from an Italian word that means *style* or *manner.* Mannerist painters directly flouted Renaissance principles of rule, order, and design. Instead of har-



Sistine Chapel, The Vatican, Vatican City (Nippon Television Network Corporation)

The Creation of Adam by Michelangelo
1511. Fresco. Figures larger than life-sized.

mony, the mannerists sought strain and discord. They created puzzling variations in scale and space, and emphasized unbalanced compositions and harsh colors.

By challenging artistic tradition, mannerism may have represented some crisis of the time, such as a loss of faith in traditional values. However, it seems more likely that the mannerists were interested primarily in experimenting with style and inventing something new in painting.

Mannerism came to Venice late in the 1500's in the art of Tintoretto. His bold and dramatic *Last Supper* (page 59) contrasts with most previous versions of this scene. In the upper room of a Jerusalem inn, Jesus meets for the last time with His disciples and tells them of His coming betrayal and death. Tintoretto placed the supper table on a diagonal, drawing the viewer backward into deep space. The light illuminates individual heads but creates no general clarity. Phantom angels sweep into the room and circle about the lantern suspended from the ceiling.

Like Veronese, Tintoretto included a number of details, such as the cat sticking its head into a basket of dishes. However, the overall effect is threatening. The exaggeration of space, the distortion of lighting effects, and the excitement of some of the gestures mark this painting as a late mannerist work. It also has many stylistic characteristics associated with the next age of European painting, the *baroque*.

The northern Renaissance. Italy was the home of the Renaissance, primarily because so much classical tradition of ancient Greece and Rome survived there. But northern Europe also produced a rich and fascinating art during the 1400's and 1500's. The center of this culture was an area in northern Europe called Flanders, which lies primarily in modern France and Belgium. Germany also produced great Renaissance painting.

People from Flanders were called Flemish. The Flemish painters cared less than the Italians about a mathematically accurate technique for perspective or a classical sense of the human form. Instead, they concentrated on building their paintings through precise details and a sense of the light falling across the picture.

The Flemish artist Jan van Eyck painted *The Annunciation* (page 28), a work with a vast variety of detail and symbolic meaning. Van Eyck was among the first European artists to work entirely in oil paint. The technique lent itself to painting highly detailed images. The precision of detail appears in the glass windows as well as in the floor patterns. Van Eyck represented every strand of the brocade on the Angel Gabriel's cloak. The light coming through the windows behind Mary has been observed so carefully that the individual panes of the window all differ from one another.

For van Eyck, the entire range of details and colors in the visible world was significant. An Italian artist would suppress "unnecessary" details, but van Eyck attempted to capture all the particulars of a scene. These details express meanings. For example, the single top window suggests the single God of the Old Testament. The three windows below symbolize the Holy Trinity of the New Testament. For other examples of van Eyck's paintings, see **Jerome, Saint**; **Renaissance** (picture: A northern Renaissance painting); **Van Eyck, Jan.**

The most prominent in the next generation of Flemish



Collection of the J. Paul Getty Museum, Malibu, California

Portrait of Pope Clement VII by Sebastiano del Piombo
About 1531. Oil on slate.
41 ½ by 34 ½ in. (105 by 88 cm).

painters in the 1400's was Rogier van der Weyden. While van Eyck was objective, van der Weyden was deeply subjective. His *The Descent from the Cross* (page 60) pushes the figures close to the viewer. The figures, nearly life-sized, produce an eerie effect because they look like painted statues in a wooden box. Emotions range from grim despair to heartbreaking anguish. Tears roll down Mary's face as she faints in sympathy with her Son's suffering.

Both van Eyck and van der Weyden remained largely free of the influence of Italian art. However, by the 1500's, the Italian Renaissance style had spread throughout Europe. One Flemish artist of the 1500's stood apart from the prevailing Renaissance styles and worked in an individual manner. Pieter Bruegel the Elder produced no school or following, other than the art of his own children. His reputation ranks high today, but for many years after his death in 1569, he was often considered as simply a painter who poked fun at the peasants of his day. However, modern historians generally see a more serious, almost philosophical side to Bruegel's art.

In his *Landscape with the Fall of Icarus* (page 60), Bruegel portrayed the Greek myth of young Icarus. The boy's father, Daedalus, fashioned wings for his young son from bird feathers and wax. Daedalus warned Icarus not to fly too close to the heat of the sun. The boy ignored the warning and flew so near the sun that the wax in the wings melted. Thus, as a consequence of his pride and foolhardiness, Icarus plunged to his death in the sea.

Bruegel's figures are relatively simple and round. He painted his landscape viewed from above, and his perspective is difficult to analyze. Bruegel saw the story as if



Alte Pinakothek, Munich, Germany (Blauel/Gnamm/Artothek)

Crowning with Thorns by Titian
About 1570. Oil on canvas.
9 ft. 2 $\frac{3}{8}$ in. by 5 ft. 11 $\frac{5}{8}$ in. (2.80 by 1.82 m).

it were occurring off the coast of Flanders, while a typical Flemish peasant plows his land. Nearby a ship sails. Two legs sticking out of the green water at the lower right provide the only evidence of Icarus's death. The drowning seems almost insignificant in the larger scheme of things. In the humanistic tradition of Italian art, the central event in a story almost always was placed at the center. But in Bruegel's painting, greater forces seem at work. Human beings, despite their pride, play only a small part in the world. For other examples of Bruegel's painting, see **Bruegel, Pieter, the Elder; Folklore; Tower of Babel.**

Albrecht Dürer was the greatest German painter of the Renaissance. He made two trips to Italy, one in 1494 and the other in 1505, hoping to discover the secret of Italian art. He never found what he believed to be the hidden formula for creating beautiful art. But he absorbed the Italian idea of the artist as important to society.

In the art of the 1500's, the portrait was a document that recorded the social position, class, occupation, or other significant aspect of the sitter. In Dürer's *Self-Portrait* (page 61), the artist made himself look like Jesus Christ. Dürer showed himself formally from the front. The portrait depicts a Christlike image, with wide staring eyes and long hair and beard. In this self-portrait, Dürer compared artistic ability with the creative power of Christ. The painting reflects the Renaissance idea of the artist as a genius. See also **Dürer, Albrecht.**

The 1600's and 1700's

Baroque is a term that originally described art that developed in Italy about 1600. The movement lasted until about 1750 in areas of Germany and Austria. The term was first used in an unfavorable way to describe the showy, extravagant art that followed the High Renaissance. However, the term lost its negative meaning and now refers loosely to all European art and architecture of the 1600's.

Applied to painting, *baroque* refers to the works of a varied group of artists in Western Europe. The works of these artists reveal distinctive national styles. These styles were supported by the Roman Catholic Church in Italy and Flanders, monarchies in France and Spain, and the powerful middle class in the Netherlands.

Despite the distinctive stylistic characteristics associated with each country, some unifying features exist in baroque painting. In general, baroque artists painted large-scale works of dynamic subjects that are realistic and emotionally intense. Artists expressed these qualities through active figures arranged diagonally within the composition. Strong colors and sharp contrasts of light and shadow heighten the theatrical presentation of the subject matter.

Baroque painting began in Roman Catholic countries where the church was confronting the effects of the Reformation. The Reformation was a religious movement that led to the establishment of Protestant churches. The Reformation prompted the Catholic Church to seek new ways to reach the faithful through art. In Catholic Italy and Flanders, artists produced works that taught religious doctrine in an easily understood fashion. Magnificent altarpieces proclaimed church beliefs clearly and directly. These two qualities are evident in the paintings of the foremost Italian baroque artist, Michelangelo Merisi da Caravaggio.

Caravaggio. Baroque characteristics that visually promote and defend the Roman Catholic faith appear in Caravaggio's *Conversion of Saint Paul* (page 62). The painting portrays the moment when Saul falls from his horse, converts to Christianity, and adopts his new name, Paul. The startling event occurs in the foreground of the pictorial space. Caravaggio intensified the drama by using abrupt contrasts of light and shadow, called *tenebrism.* The unidealized presentation of Paul, his attendant, and the horse spoke directly to the faithful. They would respond instinctively to the natural, convincing conversion of a sinner into a saint. Some artists and patrons of the time considered the realistic portrayal of such religious themes too natural. Church patrons rejected Caravaggio's altarpieces as vulgar and unsuited to a religious environment.

Caravaggio worked *alla prima*—that is, he painted directly onto the primed canvas in one layer, without preparatory painting underneath. His spontaneous method of creating his compositions differs from the deliberate approach of High Renaissance artists.

Artemisia Gentileschi was an Italian painter who became one of the most influential followers of the style



Accademia, Venice, Italy (SCALA/Art Resource)

Feast in the House of Levi by Paolo Veronese
1573. Oil on canvas. 18 ft. 3 in. by 42 ft. (5.56 by 12.80 m).

of Caravaggio. She employed realism and contrasts of light and shadow called *chiaroscuro* to portray powerful, determined heroines, especially from the Bible.

The Carracci family revived the Renaissance tradition of painting based on life drawings, sketches of nature, and models from antiquity. The three Carracci were Lodovico, the eldest, and his cousins, the brothers Agostino and Annibale. In 1585, they established an academy of art in Bologna, Italy. The conservative teachings of the school's leader, Annibale, continued the traditional style of the Italian Renaissance and offered an alternative to the radical art of Caravaggio. Annibale painted murals illustrating the classical approach to art by presenting a theme in a rational, controlled composition.

Peter Paul Rubens. The conflicting directions in Italian baroque painting merge in the work of the Flemish

Santa Giorgio Maggiore, Venice, Italy (SCALA/Art Resource)

Last Supper by Tintoretto
1594. Oil on canvas. 12 ft. by 18 ft. 8 in. (3.66 by 5.69 m).

The Descent from the Cross
by Rogier van der Weyden
About 1435. Oil on wood.
7 ft. 2 $\frac{5}{8}$ in. by 8 ft. 7 $\frac{1}{8}$ in.
(2.20 by 2.62 m).

The Prado, Madrid, Spain (SCALA/Art Resource)

Musee Royaux des Beaux-Arts, Brussels, Belgium (SCALA Art Resource)

Landscape with the Fall of Icarus by Pieter Bruegel the Elder
About 1555. Oil on canvas. 29 by 44 in. (74 by 112 cm).



Alte Pinakothek, Munich, Germany (Giraudon/Art Resource)

Self-Portrait by Albrecht Dürer
1500. Oil on wood.
25 1/8 by 18 7/8 in. (64 by 48 cm).

artist Peter Paul Rubens. Although he lived in Flanders, Rubens obtained many commissions from both public and private patrons throughout Europe. His popular paintings incorporate a balance of traditional classical idealism with the dramatic realism of his time.

In Rubens's *Battle of the Amazons* (page 29), the idealized nude figures are classical in origin, while the composition exhibits the active elements of Caravaggio's style. Like Caravaggio, Rubens conveyed the drama of the scene by placing moving figures diagonally throughout the composition and incorporating strongly contrasting areas of light and shadow. Rubens also applied vivid, rich colors inspired by his study of Venetian painting. He painted broken, agitated brushstrokes, emphasizing the energy of the battle. In his choice of subject matter, Rubens shared with Caravaggio an interest in showing the climax of the story. Baroque painters tried to stimulate viewers by portraying dramatic, exciting action.

Sir Anthony Van Dyck. Rubens operated a large studio in Antwerp and directed a crowd of apprentices and assistants. Among the talented young artists who worked at his studio was Anthony Van Dyck. Van Dyck had already become an accomplished painter when he joined Rubens in 1618 and began producing classical and religious works in imitation of his master. However, Van Dyck wanted to avoid competing with Rubens in the area of history painting, so he turned to painting portraits. Van Dyck moved to Italy in 1621 and dedicated himself to the perfection of court portraiture.

Following a brief return to Antwerp, Van Dyck moved to England in 1632, where he worked for King Charles I in London. Van Dyck established the characteristics of refined court portraiture by stressing the elegance and splendor of the royal family. In Van Dyck's paintings, figures wear lavish costumes and are surrounded by the marks of power and luxury.

In outdoor scenes, Van Dyck often showed the king on a horse or standing next to his mount. These equestrian portraits refer to the monarch's military skill and political authority. Van Dyck's most famous work is *Portrait of Charles I Hunting* (page 63), a depiction of the English king with his walking cane, his attendant, and his horse. Van Dyck presented an informal portrait of Charles at ease in the countryside. The refinement and grace of the pose, the elongated figure and hands, and the carefully detailed costume all combine to flatter the monarch. Van Dyck also painted the English queen, Henrietta Maria, and the royal children. He was a leader in portraying unassuming, innocent images of children. For other examples of baroque painting, see **Caravaggio, Michelangelo Merisi da; Clothing** (The 1600's); **Daniel, Book of; Jesus Christ** (picture: Jesus's last hours); **Rubens, Peter Paul; Van Dyck, Sir Anthony.**

Classicism. The Roman Catholic Church established the dramatic baroque style in public religious art. In contrast, many private patrons and scholars in Italy and France preferred works that exhibited a balanced, orderly presentation of classical and religious themes. King Louis XIV of France officially embraced this style, known as *classicism.* It became officially approved and encouraged with the establishment of the French Royal Academy of Painting and Sculpture in 1648. Two French artists, Nicolas Poussin and Claude, developed and popularized classicism both in France and in Italy, where they lived and worked.

Poussin differed considerably from the Baroque master Caravaggio in choice of subject matter and style. Caravaggio's dramatic paintings appealed immediately to the viewer's emotions. The composed art of Poussin spoke to the mind and required an intellectual response. Poussin believed the only suitable subjects for art were serious, uplifting stories from classical mythology, ancient history, and Christianity.

Poussin read extensively about his subject matter and then considered how best to tell the story through a painting. He proceeded methodically by carefully preparing sketches and elaborately arranging small wax figures to determine the composition.

Poussin's formal classicism appears in scenes from antiquity as well as in Christian subject matter. In his *Holy Family on the Steps* (page 64), Poussin organized the figures in a triangular arrangement on a stairway. The balanced effect of this composition emphasizes the calm, dignified content of the painting.

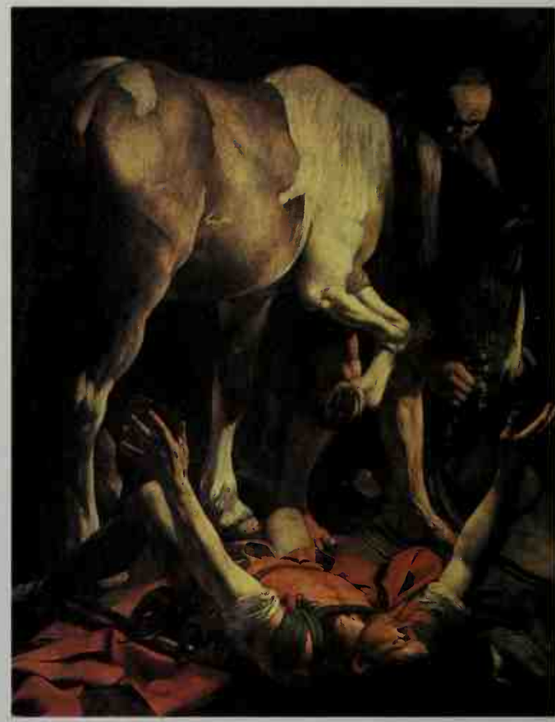
Poussin and Claude also stimulated an interest in landscape. The classical French presentation of nature is evident in Claude's *The Father of Psyche Sacrificing at the Temple of Apollo.* The painting appears in the **Classicism** article. The landscape overwhelms the small, unimportant figures in the foreground and points to the establishment of pure landscape as an acceptable subject for painters. The natural lighting and atmospheric

conditions in Claude's landscape paintings are partly based on nature studies in the Italian countryside. However, Claude carefully planned the composition. He refined any imperfections or irregularities in the actual views in his search for an idealized scene. For other examples of classical paintings, see **Mythology** (picture: The Trojan Warrior Aeneas); **Poussin, Nicolas.**

The Dutch masters. During the 1600's, the northern Netherlands, called Holland, prospered as an independent Protestant nation. Holland was a democratic country governed by wealthy bankers, merchants, and traders. Without the patronage of the church or a royal court, Dutch artists depended on the wealthy middle class to buy works of art on the open market.

The Dutch middle class looked for small paintings suitable for private homes, rather than large-scale religious, historical, and mythological works. Local artists responded to the new market demands by specializing in a particular subject, such as still lifes, seascapes, cityscapes, portraits, or genre scenes. Frans Hals perfected portraiture in Haarlem, and Jan Vermeer became a master of genre painting in Delft. Rembrandt painted a wide range of subjects in Amsterdam.

Hals painted individual and group portraits of Dutch men and women from all classes of society. In his *Banquet of Officers of the Civic Guard of Saint George at Haarlem, 1616* (this page), Hals depicted the members of a Dutch national guard celebrating during an annual feast. Earlier group portraits showed figures arranged in rows in stiff positions facing front. Hals's large canvas realistically shows the men in an active, open exchange of gestures and expressions. The excitement and frozen motion of the scene are conveyed by the parted lips, raised glass, and hoisted banners. Loose individual



Santa Maria del Popolo, Rome (SCALA/Art Resource)

Conversion of Saint Paul
by Michelangelo Merisi da Caravaggio
1601. Oil on canvas.
7 ft. 6 in. by 5 ft. 9 in. (2.29 by 1.75 m).



Frans Hals Museum, Haarlem, the Netherlands (Erich Lessing, Art Resource)

Banquet of Officers of the Civic Guard of Saint George at Haarlem, 1616 by Frans Hals
1616. Oil on canvas.
5 ft. 8 $\frac{7}{8}$ in. by 10 ft. 7 $\frac{1}{2}$ in. (1.75 by 3.24 m).



Wadsworth Atheneum, Hartford, Connecticut, Ella Gallup Sumner and Mary Catlin Sumner Collection

Saint Serapion
by Francisco de Zurbarán
1628. Oil on canvas.
47 $\frac{1}{8}$ by 41 in. (120 by 104 cm).



The Louvre, Paris (SCALA/Art Resource)

Portrait of Charles I Hunting by Sir Anthony Van Dyck
About 1635. Oil on canvas.
8 ft. 11 in. by 6 ft. 11 $\frac{1}{2}$ in. (2.72 by 2.12 m).

strokes of paint applied *alla prima* intensify the sense of movement and action.

Hals's imagery reveals the interest of Dutch artists in truthfully capturing the natural appearance of the world. This attention to realism is also evident in the still-life images of Willem Claesz. Heda and the landscape paintings of Jacob van Ruisdael. Heda's *Breakfast Table* (page 64) is a so-called breakfast piece, which featured painstakingly rendered but informally arranged food and dishes. Heda created a sense of luxury through the silver plates, the ornate goblet, and the richly detailed pie.

In his small landscape paintings, Ruisdael recorded recognizable buildings, roads, and landmarks such as windmills. In *The Mill at Wijk* and other works, Ruisdael included anonymous figures engaged in everyday activities to emphasize the commonplace beauty of the setting. This painting appears in the article **Ruisdael, Jacob van.**

Jan Vermeer focused on scenes of everyday life in Delft. Like many other Dutch artists of the 1600's, Vermeer could not earn a living by selling his paintings. He worked as an innkeeper and art dealer to support his family and painted in his deliberate, precise style when he could find time. His small number of works show women at work and play in rooms illuminated by a soft, encompassing light. Sometimes the women are engaged in solitary household chores, such as lacemaking. In other paintings, they entertain visitors in scenes of music making or casual conversation.

In *Young Woman Reading a Letter* (page 66), Vermeer exhibited his interest in the visual effects of light on various surfaces ranging from the creased map on the back wall to the soft, blurred hair surrounding the woman's face. Although Vermeer's paintings seem to record ordinary life, many of his scenes have deeper symbolic significance. For example, maps often refer to the outside, male-dominated world of business in contrast to the interior woman's world of household concerns. The realistic objects in Dutch genre paintings often have hidden symbolic meanings.

Judith Leyster, like Vermeer, specialized in scenes of everyday life. In particular, she painted boisterous scenes of tavern life and pictures of women quietly performing domestic tasks. Leyster's quick, vivid brushstrokes show the influence of Hals, while her use of chiaroscuro reflects the style of Caravaggio.

Rembrandt is the greatest Dutch artist. As a young man, he established his reputation as a portrait painter. At the same time, he depicted scenes from the Bible, classical history, and mythology in Dutch settings. Like Caravaggio, Rembrandt updated the past by showing historical figures in scenes and costumes of his time. As a careful observer of reality, Rembrandt looked to the world around him for his subjects. The resulting realistic scenes were considered crude, vulgar, and unacceptable by many critics.

As a young artist, Rembrandt preferred scenes of action and violence, but in his mature years he chose subjects of inner psychological meaning. In *The Return of the Prodigal Son* (page 65), Rembrandt captured a moment of reflection and meditation in a solemn and sober scene. In this painting of a Biblical parable, the wasteful son is embraced by his loving father in a calm, controlled composition. Rembrandt rendered the scene in



Staatliche Kunstsammlungen, Dresden, Germany (Erich Lessing, Art Resource)
Breakfast Table by Willem Claesz. Heda
1631. Oil on wood.
21 ¼ by 32 ¼ in. (54 by 82 cm).

dark earthy tones of brown and red. His subtle shading emphasizes the stillness and serenity of the story. An additional feature of Rembrandt's style is his use of thick layers of paint called *impasto* to create textures on the surface of the canvas. For other examples of Dutch painting of the 1600's, see **Aristotle; Hals, Frans; Jesus Christ** (The Nativity); **Rembrandt; Steen, Jan; Vermeer, Jan; World, History of the** (The Renaissance).

The Spanish masters. The classical themes favored by many Italian and French artists do not appear in the varied production of Spanish painters of the 1600's. Both Jusepe de Ribera and Francisco de Zurbarán depicted religious subjects for the Roman Catholic Church. The most famous Spanish painter, Diego Velázquez, painted royal portraits after an early interest in still life and genre pictures.

The influence of Caravaggio appears in the art of Ribera. He worked in Naples, which was controlled by Spain in the 1600's. There he quickly learned the dramatic realism of Caravaggio's style by studying the Italian's altarpieces in Naples. Ribera depicted the heroism and conviction of ordinary people caught up in extraordinary events. Many of his paintings show Christians becoming martyrs or other intensely powerful images of suffering and hardship.

In the art center of Seville, Francisco de Zurbarán developed a style that incorporated Caravaggio's realism with a native Spanish interest in mysticism. The devout, enthusiastic religious orders of Seville became Zurbarán's chief patrons.

Zurbarán painted *Saint Serapion* (page 63) for the Mercendarian Order of Friars in Seville. The strongly illuminated figure of the saint fills the canvas as his three-quarter-length body is pushed forward toward the viewer. The solid figure of the martyr serves as a solemn and simple focus on devotion and meditation. This mystical and sober quality is Zurbarán's contribution to painting of the 1600's.

In the works of Velázquez, the perfection of a national and individual style appears. Early in his career, Velázquez popularized *bodegones* (kitchen scenes) in which half-length figures are shown eating and cooking in kitchen settings. These paintings include elements of still lifes and are usually marked by vigorous realism and tenebrism.

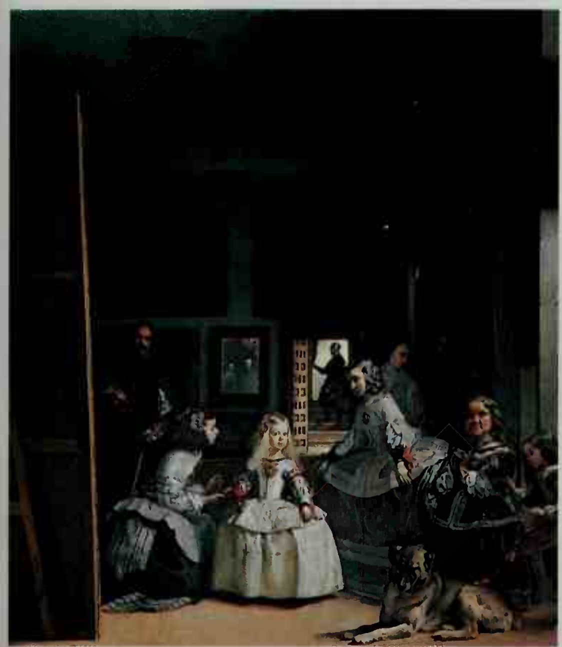
From 1623 until his death in 1660, Velázquez worked for the Spanish king, Philip IV. He established his international reputation with his royal portraits. Velázquez painted full-length portraits of the king; his wife and children; and his court, including servants, jesters, and dwarfs. In many portraits, Velázquez isolated the figures against a neutral background, focusing the viewer's attention on the face and attitudes of the sitters. In contrast to Van Dyck, Velázquez included few or no attributes of power in his images of Spanish royalty. Instead, Velázquez heightened the casual, unplanned qualities of his portraits by depicting his sitters engaged in everyday activities in informal settings.

Velázquez's mature style is revealed in his master-

Cleveland Museum of Art, Leonard C. Hanna, Jr. Fund



Holy Family on the Steps
by Nicolas Poussin
1648. Oil on canvas.
28 ½ by 44 in.
(72 by 112 cm)



The Prado, Madrid, Spain (Erich Lessing, Art Resource)
Las Meninas by Diego Velázquez
1656. Oil on canvas.
10 ft. 5 1/4 in. by 9 ft. 5/8 in. (3.18 by 2.76 m).



Hermitage Museum, St. Petersburg, Russia (SCALA/Art Resource)
The Return of the Prodigal Son by Rembrandt
About 1665. Oil on canvas.
8 ft. 8 in. by 6 ft. 10 in. (2.64 by 2.08 m).

piece, a portrait of the royal family in the artist's studio called *Las Meninas (The Maids of Honor,* page 65). This large-scale painting is a portrait of the Princess Margarita Maria. Her royal parents are reflected in the mirror on the back wall. The painter on the left is Velázquez himself. The artist masterfully united real and pictorial space by having the princess look casually out of the composition, presumably toward her parents, who stand in the same position as the viewer.

Velázquez conveyed a strong sense of realism by depicting figures in frozen motion. A sense of informality is created by the poised brush held by the painter, the initial movements of a curtsy by one of the maids, and the playful kick the dwarf gives the dog at the far right. The spontaneity of the portrait is enhanced by the way in which Velázquez suggested, rather than outlined, forms. His broad handling of rough, broken brushstrokes also produces a powerful sense of light and atmosphere throughout the work. For other examples of Spanish painting of the 1600's, see **Greco, El; Moors; Murillo, Bartolomé Esteban; Resurrection; Velázquez, Diego**.

Rococo painting. The rococo style developed in France after the death of Louis XIV in 1715. At that time, aristocrats left the court at Versailles and moved to Paris. There, they became customers for a new style of refined, delicate art that would ornament their city homes. From France, the rococo style spread as an international court style to Germany and Austria. The term *rococo* comes from *rocaille,* the rock and shell designs that decorated the outdoor parks of the French nobility. In rococo interiors, curved, organic designs provided the setting for small, elegant works of art.

Rococo painting had its beginnings in the late baroque period. At the end of the 1600's, the French Academy divided into two opposing groups, the Poussinists and the Rubenists. The Poussinists followed the stylistic characteristics of Nicolas Poussin. They respected classical design, careful contour lines, and uplifting and intellectual subject matter. In the 1700's, the Poussinists were overpowered by the Rubenists, who embraced the rich, colorful, and emotional art of Peter Paul Rubens. French rococo artists adapted the dynamic compositions and energetic brushwork associated with Rubens. These artists painted lighthearted, frivolous subjects, such as courtship, the theater, and games.

Antoine Watteau was an early supporter of the rococo style. He established a new category of painting called the *fête galante,* which loosely refers to scenes of couples courting in outdoor settings. In Watteau's *The Island of Cythera* (also known as *The Embarkation for Cythera,* page 66), a hazy landscape of pastel colors provides the setting for slender, graceful men and women. They stand on the shore of the island of Aphrodite, the Greek goddess of love. Watteau refined Rubens's robust colors by applying a pearly white underpaint that glows through the blues, reds, and greens of his figures and landscape. Watteau's loose handling of paint builds indistinct outlines throughout the composition, heightening the sense of light and movement.

Elisabeth Vigée-Lebrun was one of the most fashionable French painters of the rococo period. She painted attractive, flattering portraits, devoting much attention to rich fabrics and fine clothes. Vigée-Lebrun's subjects included members of the French royal family as well as important members of French society.

François Boucher was Watteau's successor. Boucher continued the rococo style by painting cheerful mytho-

logical scenes and informal portraits for the French aristocracy. As a popular painter of the French court, Boucher depicted a wide range of themes in his graceful, delicate style.

Jean Honoré Fragonard, a pupil of Boucher, was the last great rococo painter. Working during the mature period of rococo art, he continued the formal characteristics of this charming style in *Bathers* (page 67). This painting was inspired by the colors of Rubens and the technique of Frans Hals. *Bathers* shows the rococo preference for playful themes of love. Fragonard's broken brushstrokes suggest, rather than define, the glowing bodies of nude women bathing in a frothy pond. For another example of rococo painting, see **Boucher, François.**

Neoclassicism refers to a severe style that developed in France at the end of the 1700's in reaction to the playful quality of rococo art. Neoclassicism dominated French art from the late 1700's to the early 1800's. It signaled a return to the art of Poussin and the French Academy style of the 1600's. Stylistically, neoclassical artists valued the formal elements of line and form over color. They considered the proper subjects for art to be moralizing themes of grand historical significance.

In addition to the influence of Poussin, neoclassical artists were inspired by discoveries at the ancient Roman cities of Pompeii and Herculaneum. The ruins of the cities were excavated in the 1700's after lying buried in volcanic debris for hundreds of years. Excavations there revealed for the first time actual archaeological



Rijksmuseum, Amsterdam, the Netherlands

Young Woman Reading a Letter by Jan Vermeer
About 1665. Oil on canvas.
$18\frac{3}{8}$ by $15\frac{3}{8}$ in. (47 by 39 cm).

The Louvre, Paris (Erich Lessing, Art Resource)

The Island of Cythera (also known as *The Embarkation for Cythera*) by Antoine Watteau
1717. Oil on canvas. 4 ft. $2\frac{3}{8}$ in. by 6 ft. 4 in. (1.28 by 1.93 m).



The Louvre, Paris (SCALA/Art Resource)

Bathers by Jean Honoré Fragonard
Mid-1700's. Oil on canvas.
25 1/4 by 32 1/2 in. (64 by 83 cm).

evidence of the interiors, clothing, and lifestyles of classical antiquity.

Jacques Louis David was the leader of the neoclassical movement. He returned to the serious academic traditions that dominated French painting before the lighthearted rococo age. In *The Oath of the Horatii* (this page), David painted a straightforward story without distracting details. The clothing and architecture are based on actual historical examples from Roman antiquity. The monumental figures are arranged in rigid poses across a shallow space in imitation of sculptural decorations called *friezes* found in classical buildings. In the stagelike setting of the painting, the harsh lighting and cool colors emphasize the crisp, hard outlines that define the forms in the composition. The surface of the painting is smooth and highly finished, emphasizing the firmly modeled forms. Brushwork is rarely visible. For examples of neoclassical painting, see **Clothing** (The 1700's); **David, Jacques Louis; French Revolution** (picture: The death of Marat); **Socrates.**

The 1800's

By 1820, an increasing number of artists came to consider neoclassicism old-fashioned and no longer meaningful. However, its influence lasted into the 1890's, particularly in France. This influence resulted from the fact that many artists from Europe and the United States went to Paris to study. They enrolled at the state-sponsored École des Beaux-Arts (School of Fine Arts). The school became the most important art school in the Western world and the model for most art schools in the 1800's. Most students also received private art training in Paris. Both art schools and private teachers based their instruction on neoclassical principles until the early 1900's. The term *academic* has been applied to those artists who followed the conservative ideals taught at the art schools of the 1800's.

Most academic teachers of art in Paris taught their students that history, including mythology and the Bible, provided the most significant subject matter. From the academy's point of view, any other subject matter lacked important moral or political meaning. Students learned to emphasize drawing and carefully composed compositions rather than brushwork, color, and natural impulses. Adventurous artists of the later 1800's received unfavorable reviews of their work. Exhibition juries rejected paintings by artists whose style and subject matter did not meet the rules of academic art.

Later neoclassicism. From the 1820's to the 1860's, the French painter Jean Auguste Dominique Ingres was the most famous neoclassical artist. He departed from



The Louvre, Paris (SCALA/Art Resource)



The Oath of the Horatii
by Jacques Louis David
1784. Oil on canvas.
10 ft. 9 7/8 in. by 13 ft. 11 3/4 in.
(3.30 by 4.26 m).

earlier neoclassical ideals by rejecting the principle that art had to preach a strong message. But he did argue that artists should paint historical scenes and that all art should be based upon skillful drawing. His smoothly painted, idealized portrait *Comtesse d'Haussonville* (page 71) demonstrates one of the many ways the neoclassical style continued after the time of David.

A late flowering of the neoclassical tradition occurred in England from the 1860's to the 1890's. Such artists as Sir Lawrence Alma-Tadema, Lord Frederic Leighton, and Sir Edward Poynter painted romantic visions of the classical past.

Romanticism was the major new trend in the arts of the early 1800's. Unlike neoclassicism, romantic art was not linked by subject matter or style. The unifying element among romantics was a common desire to express the individual's innermost beliefs, feelings, or emotions. The search for a personal inner voice was often expressed in self-portraits.

The romantics also made an important contribution to painting by popularizing landscapes. The academic system shunned landscape painting. The academic avoidance of landscape actually proved an advantage to the romantics, allowing them to experiment in an area where few rules existed.

The German artist Caspar David Friedrich painted some of the most powerful and mystical landscapes of the romantic period. A typical example is *Village Landscape in the Morning Light* (page 69). Friedrich was deeply patriotic and religious. He believed that only through landscape could he capture his most personal feelings regarding his love for his country and his belief that God was most closely felt in nature. Friedrich's paintings are based upon careful studies of the natural world. However, his works are filled with a mysterious, otherworldly quality that goes beyond nature and demands a strong emotional response from the viewer.

The English artist John Constable also explored the new freedom of self-expression through landscape painting. Constable felt a deep love for the landscape and lifestyle of Suffolk in eastern England, where he grew up. To express this strong attachment, he portrayed a quiet, lush, and beautiful Suffolk landscape. There everyone, including children and laborers, lived in harmony with the bountiful land and with God. Constable expressed many of these ideals in *Boat-Building near Flatford Mill* (page 69). The rough brushstrokes and broken color capture a feeling of air, light, and wind.

Constable's approach to painting created a sense of real living nature that influenced romantic painters in France, particularly Camille Corot and the Barbizon School, led by Jean François Millet and Théodore Rousseau. These artists captured the simple beauty of the countryside around the village of Barbizon, near Paris. Their paintings often stress the strong bonds between the peasants and their environment. Of these artists, Millet particularly emphasized the difficult but pious life of the hard-working French peasants.

In contrast to the work of Constable or the Barbizon School, J. M. W. Turner of England took a different approach to the study of nature. His late work in particular explores in a personal way the strong effects of color and atmosphere. Turner preferred warm colors, swirling paint, and light that seems to dissolve forms. He created an emotional interpretation of the power and mystery of nature that is far more troubling than the work of other landscape painters of his time. A good example of this more pessimistic vision of nature is his *Snowstorm: Steamboat off a Harbour's Mouth* (page 71). For all its brilliant and beautiful effects of light, the painting presents the viewer with a vision of humanity unable to control the forces of nature.

The Prado, Madrid, Spain (SCALA Art Resource)



The Executions of 3rd May, 1808
by Francisco Goya
1814. Oil on canvas.
8 ft. 6 1/4 in. by 11 ft. 3 7/8 in.
(2.61 by 3.45 m).



The Raft of the Medusa
by Théodore Géricault
1819. Oil on canvas.
16 ft. 1 ½ in. by 23 ft. 6 in.
(4.91 by 7.16 m).

The Louvre, Paris

The romantic notion that one must deal with one's innermost fears and thoughts is perhaps most often found in the work of the Spanish artist Francisco Goya. As he grew older, Goya became increasingly depressed and discouraged about his own life and humanity in general. Goya was one of the first artists to persistently explore the dark side of the human mind. Some of his work evokes a disturbing nightmare full of haunting thoughts about life and war.

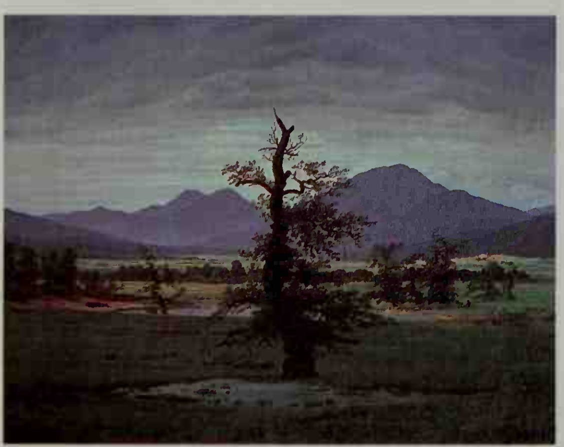
Romantic artists were among the first to feel it was the artist's responsibility to respond to events of their day. After witnessing the horrors of the French occupation of Spain that began in 1808, Goya painted his famous *The Executions of 3rd May, 1808* (page 68). The painting shows the cold-blooded execution of several Spaniards suspected of participating in an uprising against the French. Goya portrayed faceless, anonymous French soldiers who methodically shoot the civilians. For the first time, an artist made a modern statement about war, emphasizing not heroes but helpless victims. The strongly contrasted lights and darks and the rich, loose brushwork add to the emotional impact of the work. Goya was telling the viewer that war is a senseless, brutal act. He dealt even more honestly and graphically with the darker sides of war in his series of etchings the *Disasters of War.*

In France, the first two major romantic artists were Théodore Géricault and Eugène Delacroix. Géricault's *The Raft of the Medusa* (this page) deals with an event of his time, the horrible suffering of survivors of the wreck of a French ship off west Africa in 1816. In contrast to the neoclassical style, Géricault's brushwork, color, and lighting produce an intensely emotional reaction from the viewer.



Victoria and Albert Museum, London (Art Resource)

Boat-Building near Flatford Mill by John Constable
1815. Oil on canvas. 20 by 24 ½ in. (51 by 62 cm).



Alte Nationalgalerie, Berlin, Germany (Artothek)

Village Landscape in the Morning Light
by Caspar David Friedrich
1822. Oil on canvas. 21 ½ by 28 in. (55 by 71 cm).



The Louvre, Paris (Erich Lessing, Art Resource)

The Women of Algiers
by Eugène Delacroix
1834. Oil on canvas.
5 ft. 10 $\frac{7}{8}$ in. by 7 ft. 6 $\frac{1}{8}$ in.
(1.80 by 2.29 m).

Like many other romantics, Delacroix was fascinated with non-Western cultures. He was particularly attracted to the Middle East, where France was establishing colonies. His *The Women of Algiers* (this page) is a typical Western fantasy of another culture in the early 1800's. Delacroix portrayed beautiful women and exotic clothing, accessories, and architecture, creating a sense of mood and mystery through the use of deep shadow. For other examples of romantic painting, see **Barbizon School; Columbus, Christopher** (Return to Spain); **Goya, Francisco; Greece** (History); **Turner, J. M. W.**

Art for a new public. By the 1830's, growing numbers of artists were creating works meant to appeal to a new art audience. This audience consisted of the unsophisticated but enthusiastic European middle class. These people attended art exhibitions in rapidly increasing numbers.

Victoria and Albert Museum, London (Art Resource)

The Old Shepherd's Chief Mourner by Sir Edwin Landseer
1837. Oil on canvas. 18 by 24 in. (46 by 61 cm).

Some artists, such as Paul Delaroche of France, painted sentimental historical scenes. Other painters, including Sir David Wilkie of Scotland and Sir Edwin Landseer of England, concentrated on storytelling or sentimental scenes of everyday life in addition to historical painting. Landseer's *The Old Shepherd's Chief Mourner* (this page) is a typical example of pictures that appealed to the new popular taste. The painting shows a sad dog, the only mourner at the draped coffin of its master, surrounded by the remains of their humble but happy existence.

Realism. By the late 1840's, an increasing number of painters believed that artists should focus on the life of their day, presenting it in an accurate and objective manner. Scenes of everyday life did appear in art of the early 1800's, but the subject became the dominant trend from about 1850 to the end of the 1890's. Artists who specialized in creating scenes of daily life are now called *realists.*

The most famous and innovative realist painter was Gustave Courbet of France. Courbet argued that artists must paint scenes of everyday life taken only from their personal experiences. They should present the subjects in a style that would convince the viewer that the event had actually happened in the manner the artist showed it.

Courbet's *The Stonebreakers* (page 72) shows a young boy and an old man earning a living at the exhausting and low-paying job of breaking stones. As a realist, Courbet's approach to the subject differs greatly from that of earlier artists. For example, Landseer would have emphasized the storytelling aspects of the scene and made it more emotional. Courbet's loose style of painting, with its gritty earth tones, downplays these two ele-

ments. The painting illustrates how Courbet broke with both the French neoclassical and romantic traditions by limiting himself to seemingly objective views of daily life.

The impact of Courbet in France was tremendous. Academic artists called his work crude, vulgar, and pointless. But many young painters in Paris immediately began to portray scenes of modern life in an honest and unsentimental fashion. For another example of realist art, see the article **Courbet, Gustave.**

The Pre-Raphaelite Brotherhood was a group of English painters founded in 1848 who were influenced by both romanticism and realism. They called themselves Pre-Raphaelites because they wanted to revive the purity and sincerity they saw in Italian art before Raphael. The leading Pre-Raphaelite painters were William Holman Hunt, Sir John Everett Millais, and Dante Gabriel Rossetti. Many of their works deal with everyday life, such as scenes of woodcutters, roadbuilders, poor children, and young lovers. Other works deal with the Bible and literature.

Whatever their subject, many of the Pre-Raphaelites painted in great detail, often copied literally from nature. Millais's *Ophelia* (page 73) is based upon a character from William Shakespeare's *Hamlet.* Millais showed Ophelia slowly drowning after she had been driven out of her mind by her father's death and Hamlet's cruel rejection of her love. The idea for the painting comes from literature, but the method was based on the careful study of real life. The artist actually had a model wear an antique dress and pose floating in a heated bathtub. The choice of colors was unusually vivid as the artist attempted to copy actual sunlight. Many Pre-Raphaelite landscapes capture a sense of brilliant light as effectively as the impressionist painters did 10 or 20 years later.

The combination of close observation of nature and imaginary events frequently gives an odd feeling to Pre-Raphaelite paintings. Inspired by Rossetti, many later Pre-Raphaelite artists, such as Sir Edward Burne-Jones, preferred to abandon the study of nature for a more dreamlike vision of the past. For another example of Pre-Raphaelite painting, see **Rossetti, Dante Gabriel.**

Edouard Manet and the impressionists. The early French realists concentrated on scenes of country life. However, beginning in the 1860's, Edouard Manet and other French artists of his time began to focus on urban themes. Manet's *Music in the Tuileries Gardens* (page 74) successfully captures a sense of the newly leisured middle classes relaxing and listening to music in a park near the Louvre museum in Paris.

Manet included little detail in his paintings and did not carefully model his figures. He believed that his apparently rapid, impulsive brushwork would convince the viewers they were looking at a scene actually observed by the artist. The French art establishment attacked Manet's everyday subject matter and his sketchy style. As a result, the public rarely saw his art during his lifetime.

Manet's approach to art had a major influence on a group of art students of the 1860's who later became known as the *impressionists.* They agreed with Manet's insistence that artists portray the experience of average city dwellers in a natural, unplanned style. Such a style, they believed, captured the movement and energy of their age.

The impressionists initially included Edgar Degas, Claude Monet, Camille Pissarro, Pierre Auguste Renoir, and Alfred Sisley. They were eventually joined by such artists as Mary Cassatt, Berthe Morisot, and Gustave Caillebotte. All were influenced by French and English romantics as well as realists, but they admired no artist



Tate Gallery, London (Art Resource)

Snowstorm: Steamboat off a Harbour's Mouth by J. M. W. Turner
1842. Oil on canvas. 35 ½ by 47 ½ in. (90 by 121 cm).



The Frick Collection, New York City

Comtesse d'Haussonville by Jean Auguste Dominique Ingres
1845. Oil on canvas. 51 ⅞ in. by 36 ¼ in. (132 by 92 cm).

more than Manet. In the 1870's, he in turn would be inspired by these younger artists.

In most impressionist pictures, the figures are ordinary middle-class city dwellers like the artists. The paintings celebrated the Paris of grand boulevards and exciting night life. Even when the impressionists painted village and riverbank scenes, they usually showed the weekend activities of Parisians taking day trips into the nearby countryside. An example is Renoir's *The Luncheon of the Boating Party,* which appears in the article **Renoir, Pierre Auguste.**

Some impressionists, including Degas, Cassatt, and Caillebotte, preferred to work traditionally, basing their final paintings on drawings or studies. However, most impressionist artists developed a revolutionary style that involved working directly from their subject, not from preparatory studies. For example, in his *Two Sisters,* Renoir applied the brushwork quickly and thickly. The colors are extremely bright, and the modeling of the forms is not emphasized. This painting appears in the **Impressionism** article.

As a result of years of carefully studying nature, the impressionists produced paintings full of sparkling light, shimmering water, and other effects never before seen in art. Whether in city or rural scenes, the human figures are portrayed in harmony with their environment. Never previously had the passing or momentary qualities of nature and human activities been captured so convincingly. For other examples of paintings by Manet and the impressionists, see **Manet, Edouard; Alabama** (ship); **Monet, Claude; Morisot, Berthe; Pissarro, Camille.**

New visual sources. The work of the French realists and impressionists looks far different from the paintings created earlier in the 1800's, largely because of the impact of new visual sources. The desire to make things look "objectively real" occurred in the years just after photography became available to the public. Some of the impressionists' freshest and most creative ideas may have come from looking at photographs. These ideas include figures cut off at the edge of the painting, unbalanced compositions, and blurred figures. *The Dancing Class* by Edgar Degas is an example. It appears in the article **Degas, Edgar.**

The impressionists and other artists also took their subject matter from illustrations published in popular magazines of the day. In addition, Japanese prints, collected by Manet and other artists, played a central role in art of the later 1800's. These prints emphasized cut-off figures and unusual compositions, scenes viewed from above, flat and unmodeled forms, and bright colors. Several of Mary Cassatt's paintings, including *The Bath,* are brilliant reinterpretations of ideas she gained from studying Japanese art. The painting appears in the article **Cassatt, Mary.** The concept of looking at non-Western sources for fresh ideas would become increasingly popular during the late 1800's and early 1900's.

Painting outside France. Realism was the most popular art movement from about 1850 to 1900. In England, the leading realist painter was William Powell Frith. During the 1850's and 1860's, he painted vast crowd scenes that portrayed the action of people from many walks of life. Even French academic artists, including James Tissot, portrayed the life of their times. Some of Tissot's pictures poke fun at the attitudes of the newly rich in London who were trying to learn how to act in high society.

Some realists had important comments to make about society. In Russia, a group of artists called the Wanderers created works that toured from city to city. The paintings dealt with the chief problems of the day, including poverty, lack of education, and poor medical care. To these painters, artistic issues were secondary to their desire for reform that would correct social injustice. Many paintings of Ilya Repin portray the hard life of peasants. In England, such young artists as Sir Luke Fildes, Sir Hubert von Herkomer, and Frank Holl portrayed the difficult condition of the homeless, the elderly, and strikers. These artists are now called *social realists.*

Realism was also popular in the United States. Winslow Homer created memorable scenes of everyday life

Formerly in the Gemäldegalerie, Dresden, Germany; destroyed in 1945 (Art Resource)



The Stonebreakers
by Gustave Courbet
1849. Oil on canvas.
5 ft. $2\frac{3}{8}$ in. by 8 ft. 6 in.
(1.59 by 2.59 m).

of New Englanders and Maine fishing crews. Thomas Eakins returned to Philadelphia after learning neoclassical techniques in Paris to create powerful realist portraits. An example is his portrait of poet Walt Whitman in the article **Whitman, Walt.** The African American artist Henry Ossawa Tanner, a student of Eakins, subtly captured the spiritual side of a humble family in *The Thankful Poor* (page 76).

The international impact of impressionism was not felt until the 1890's and early 1900's. By then, followers of French impressionism could be found throughout the world. Besides the American-born Mary Cassatt, the most famous American impressionist was Childe Hassam. However, many young artists did not really understand impressionism, equating it simply with middle-class subject matter, bright colors, and loose brushwork.

The art world, 1850-1900. During the later 1800's, art enjoyed unprecedented popularity. Each year, thousands of visitors attended exhibitions of new artworks held in most Western European countries. The two most famous were the Salon exhibition in Paris and the Royal Academy of Arts exhibition in London. Enthusiastic visitors went to these shows to be instructed and entertained. In the days before motion pictures or television, no other medium had the impact of painting. Viewers could see history come alive in the works of Ingres and Alma-Tadema. Beautiful landscapes with happy peasants and contented animals satisfied the nostalgic needs of the city dwellers. Genre scenes by Frith or the impressionists captured everyday middle-class urban existence in all its variety. Some paintings were so popular that railings had to be placed in front of them to keep the audiences from getting too close.

Popular artists, such as Alma-Tadema and the French academic painter William Bouguereau, became millionaires. They enjoyed fame and social status rivaling today's movie stars. They made vast sums of money not only from their paintings but also from the sale of engravings that reproduced their work.

The profits to be made from art led to an increasingly important role for art dealers. Art critics also began to play an essential part for the first time. Many exhibition visitors felt they lacked the necessary understanding of art to absorb the thousands of works in the large exhibitions. They looked to the critics for guidance. Many critics wrote for art magazines, another popular way people learned about art.

Women artists. Unprecedented numbers of women became painters during the 1800's, but they rarely enjoyed the success and popularity of male artists. This inequality resulted from several factors. Women were not allowed into the best art schools, primarily because it was considered improper for women to study and paint a nude model. Thus, women lacked the necessary training to compete with men in the area most admired in the academic world, figurative and historical painting. This exclusion also kept women from making the political and social contacts necessary to succeed in the competitive art world.

The English painter Emily Osborn explored the difficulties faced by women attempting to break into the man's world of art in *Nameless and Friendless* (this page). The painting shows a poor young woman, apparently a widow, finding her art treated with disdain by a pompous male art dealer. The gaze of the two men watching at the far right implies that they admire her as a beautiful woman but do not take her seriously as a creative artist.



Tate Gallery, London (Art Resource)

Ophelia by Sir John Everett Millais
1852. Oil on canvas. 30 by 40 in. (76 by 102 cm).

Young female art students believed they lived in a promising period in spite of the many difficulties they were forced to overcome. Private coeducational art schools were common, as were schools for women only. But even these schools would not allow women to work from nude models until the turn of the century. The large national exhibitions exhibited many works by women, partly because entries were submitted anonymously. By the mid-1800's, women also began to hold their own private exhibitions.

The most significant show of women's art in the 1800's was held at the Chicago World's Columbian Exposition in 1893. Mary Cassatt painted the mural *Modern Woman* especially for the Women's Building. Women also showed their work by joining movements or groups of male artists who were treated as outsiders because of the radical nature of their art. For example, both Cassatt and Berthe Morisot played central roles in impression-



Private collection

Nameless and Friendless by Emily Osborn
1857. Oil on canvas. 32 $\frac{1}{2}$ by 41 in. (83 by 104 cm).

National Gallery, London

Music in the Tuileries Gardens by Edouard Manet
1862. Oil on canvas. 30 by 46 $\frac{1}{2}$ in. (76 by 118 cm).

ism when that movement was scorned by the art establishment.

The most famous woman artist of the 1800's was the French painter Rosa Bonheur. The sale of her paintings and the engravings of her pictures enabled her to live in a grand château in the countryside near Paris. Bonheur specialized in animal paintings. Her best-known work was *The Horse Fair,* which appears in the article **Bonheur, Rosa**. Animal themes were popular in the 1800's, and only Sir Edwin Landseer of England was considered Bonheur's rival. Bonheur had the ability to portray beautiful, majestic, and spirited animals. She often showed animals playing an essential part in agriculture, generally working in harmony with people, and at times displaying human emotions.

In England, Elizabeth Thompson (who later became Lady Butler) was the only woman painter who matched Bonheur's fame. Thompson was the first woman artist to succeed in military painting. Her painting *Calling the Roll After an Engagement, Crimea* (this page) was one of the most popular pictures ever exhibited in a Royal Academy show, and was purchased by Queen Victoria. Thompson's subject is the aftermath of a hard-fought battle between the English and the Russians during the Crimean War of the 1850's. She did not focus on the glories of victory. Instead, she presented a close-up look at



Calling the Roll After an Engagement, Crimea
by Elizabeth Thompson
1874. Oil on canvas.
3 ft. 2 $\frac{1}{2}$ in. by 6 ft. $\frac{3}{8}$ in.
(98 by 184 cm).

the emotional and physical exhaustion of the soldiers as they struggled to answer roll call. Her gritty realism became immediately popular, because never before had the British public been so exposed to the true nature of war.

Today, the impressionist painters Mary Cassatt and Berthe Morisot are the most popular female artists of the 1800's. Both organized and participated in group exhibitions and helped sell impressionist works to rich friends. Their art differs from that of male artists in its emphasis on the daily lives of middle-class women. Cassatt and Morisot especially painted the domestic existence of these women, often focusing on themes of parents and children. For examples of their domestic themes, see **Cassatt, Mary; Morisot, Berthe.** The two women also painted scenes of their summer vacations as well as their urban lives, such as riding in carriages or attending the opera.

Postimpressionism. Unlike impressionism, postimpressionism was not a movement of artists working toward similar goals. The term has been used to refer to several artists who were influenced or taught by the impressionists, but who later rejected or modified that group's ideas. The postimpressionist painters, with their varying styles, now are among the most admired figures in the history of art.

The postimpressionists were little known during their lifetimes, but shortly after their deaths they had a tremendous impact on the young experimental artists of the early 1900's. The most influential postimpressionists were Paul Cézanne, Paul Gauguin, Georges Seurat, Henri de Toulouse-Lautrec, and Vincent van Gogh.

Cézanne painted landscapes that stressed what he felt was lacking in the impressionist approach—form and mass. In addition, his still lifes and portraits had a huge impact on artists of the early 1900's. For example, *Still Life with Commode* (this page) taught the cubist artists Pablo Picasso and Georges Braque that space and perspective could be manipulated in any way the painter chose.

Both Gauguin and van Gogh wanted to express their innermost feelings through their art. *The Starry Night* (page 39) shows how van Gogh achieved this goal through his use of intensely brilliant color; thick, rapidly applied brushstrokes; and expressive line. Few artists have been able to equal the passionate intensity of his paintings, which he filled with both hope and pain. Van Gogh's choices of color and subject matter often had an emotional and personal meaning for him. He was a key influence on the Norwegian artist Edvard Munch and, through Munch, the German expressionist painters of the early 1900's.

Gauguin was a friend of van Gogh, but he explored his personal feelings in a different way, as can be seen in his *The Vision After the Sermon* (also called *Jacob Wrestling with the Angel,* this page). Gauguin had first painted in an impressionist style. However, in *The Vision After the Sermon,* he developed a style that enabled him to create a clearly symbolic image rather than a lifelike study of nature. The painting represents the thoughts or imaginings of peasants in the French province of Brittany after hearing a sermon about the Biblical story of Jacob wrestling an angel. Using flat, bold colors and strong patterns, Gauguin creates a dreamlike vision far removed from the everyday world.

Like much of Gauguin's work, *The Vision After the Sermon* provokes more questions in the mind of the viewer than it answers. Gauguin would later search for purity and simplicity in both his life and his art by settling on the island of Tahiti.

Toulouse-Lautrec is best known for his paintings and lithographs of Parisian night life in the 1880's and 1890's. He painted scenes of Paris cabarets and music halls as well as portraits of dancers, singers, clowns, and prostitutes. Toulouse-Lautrec was strongly influenced by Edgar Degas and Japanese prints. He was a master at capturing movement. His forms were flat with curved lines. Many of his scenes of night life were energized by bright colors, vivid lighting, and strong contours. An example is *At the Moulin Rouge,* which appears in the article **Toulouse-Lautrec, Henri de.** He painted many of his oils on unprimed cardboard, so that the neutral whitish color of the board became part of the design.

Georges Seurat created a style of painting variously



The Harvard University Art Museums, Cambridge, Massachusetts, Bequest-Collection of Maurice Wertheim, Class of 1906

Still Life with Commode by Paul Cézanne
About 1888. Oil on canvas. 25 5/8 by 31 7/8 in. (65 by 81 cm).



National Gallery of Scotland, Edinburgh (Bridgeman/Art Resource)

The Vision After the Sermon (also known as *Jacob Wrestling with the Angel*) by Paul Gauguin
1888. Oil on canvas. 28 1/4 by 36 1/2 in. (72 by 93 cm).



The Thankful Poor
by Henry Ossawa Tanner
1894. Oil on canvas.
49 by 35 ½ in. (124 by 90 cm).

Private collection (Art Resource)

called *pointillism, neoimpressionism,* or *divisionism.* The most famous example of this style is *Sunday Afternoon on the Island of La Grande Jatte* (page 29). Seurat believed that by using an organized color system of carefully placed contrasting dots, he could create works that would glow with intensity when viewed from a distance. Seurat also wished to restore to the human figure a stronger sense of solidity than the figures found in impressionist paintings. The strange stiffness of Seurat's human figures suggests that his silhouettes may have been partially inspired by Egyptian art.

Traditionally, *La Grande Jatte* has been interpreted as a picture of working-class and middle-class people enjoying a Sunday afternoon of relaxation. However, some modern art historians have called attention to the fact that nobody is outwardly happy, no figure looks at any other figure, and few people interact. These historians claim that Seurat actually meant the painting to condemn the impersonal society of the late 1800's. For other examples of postimpressionist painting, see **Cézanne, Paul; Gauguin, Paul; Postimpressionism; Van Gogh, Vincent.**

Symbolism. The symbolists were an international group that flourished particularly in the 1890's. Like the works of the romantics, the art of the symbolists varies tremendously in both style and subject matter. Generally, symbolist painting reflects a growing demand for more spiritual, emotional, and personal approaches to art in a period dominated by realism and impressionism. From these viewpoints, Gauguin is often called a symbolist, as are some other postimpressionist artists. The writings of symbolist authors inspired many young artists. So did the fantasies painted by such older artists as Dante Gabriel Rossetti and Sir Edward Burne-Jones in England and Gustave Moreau and Odilon Redon in France.

Many symbolists were unhappy with the nature of capitalist urban society in the late 1800's. They objected to such social ills as poverty amid great wealth, pollution, and the shallow values they saw in the middle class. They were also unhappy with how industrial development and new technologies were altering society. Because the symbolists were displeased with the everyday world around them, they retreated inward, preferring to deal with their own personal feelings and interests. Because symbolist art was not appreciated in conservative circles, many symbolists formed groups and held their own exhibitions.

No symbolist better expressed the anxieties felt during the late 1800's than Edvard Munch of Norway. His haunting painting *The Scream* portrays the inner turmoil so many people felt. The painting's composition seems to endlessly echo the isolated figure's cry of fear and loneliness. The work appears in the article **Munch, Edvard.** For another example of Munch's vision of human isolation, see **Norway** (Way of life).

The 1890's were also a period when many men were confused about the changing roles of women in Western society. Women were demanding and slowly gaining increased political, social, and sexual rights and power. Many men observed these changes between the sexes with fear and uncertainty. In reaction, some male symbolist artists painted images of women who were both beautiful and dangerous, sometimes deadly, to men. An example is *Judith with the Head of Holofernes* (page 77) by the Austrian symbolist Gustav Klimt. The artist based the scene on a Biblical story about a woman who saves her town by beheading the leader of a besieging army. For an example of symbolist painting, see **Prometheus.**

Legacy of the 1800's. The art world of the 1800's ended in great confusion and excitement. Many of the

old pictorial traditions popular since the Renaissance were coming to an end. These traditions included deep logical space, linear perspective, and carefully modeled forms. Artists of the later 1800's engaged in experiments with space, two-dimensional forms, and the personal and expressive use of color, brushwork, and line. Because of the efforts, inspiration, and doubts of many artists of the late 1800's, the early 1900's would prove to be one of the most important and innovative periods in art history.

The 1900's in Europe

The Fauves. By the year 1900, a new approach to painting had become established in France. This new approach included the work of the impressionists and postimpressionists. One artist who became interested in postimpressionist painting was Henri Matisse. In the fall of 1905, Matisse exhibited a number of bold, colorful pictures at the Salon d'Automne, a famous exhibition in Paris. He was joined by several friends and colleagues, including André Derain, Albert Marquet, and Maurice de Vlaminck. One critic who saw this exhibition referred to the artists as the *fauves* (wild beasts). This term became the name of the first major art movement of the new century.

Loosely defined, the Fauve style consisted of painting that portrayed simplified views of nature filled with pure, concentrated color applied with rapid brushstrokes. There was little mixing of raw pigment and almost no modeling or shades of color.

The Fauves disbanded in 1907, and the artists continued to develop separately many of the ideas they had shared as a group. After 1907, Matisse moved away from art that represented nature into art that was more idealized and abstract. His *The Dance I* (page 78) employs a radical reduction of all pictorial techniques. There is less attention to drawing, spatial construction, and surface texture. What does emerge in *The Dance I* is the intense color, which became exaggeratedly expressive as Matisse abandoned the brushwork of his earlier Fauve canvases. For other examples of Fauve painting, see **Derain, André; Fauves; Matisse, Henri; Rouault, Georges.**

Cubism, like the Fauves, was a movement that grew out of the influence of postimpressionism. But the cubist paintings of Pablo Picasso and Georges Braque, the leading cubists, were far different from the Fauve works of Henri Matisse. Picasso and Braque indicated a new set of goals for what painting might achieve in the 1900's.

Picasso was born in Spain but settled in Paris in the early 1900's. His first works were heavily influenced by the French symbolists. In paintings such as *The Old Guitarist,* which appears in the **Color** article, Picasso used mainly blue tones. Blue colors dominate in other Picasso works of this time, known as the artist's "blue period." The blue paintings are marked by a melancholy feeling, portraying such subjects as beggars, the homeless, and starving children.

Picasso's blue period lasted more than three years and was followed by the "rose period," which emphasized rose-colored pigments. Picasso abandoned this style in 1907 when he began exploring his interest in so-called "primitive" sculpture from such non-Western lands as Africa and the Pacific Islands.

Perhaps Picasso's most famous painting is *Les Demoiselles d'Avignon,* which appears in the **Cubism** article. Picasso began the painting out of an impulse to combine the classical sculpture of the pre-Roman Iberian culture (present-day Spain and Portugal) with the raw, expressive power of African masks. The painting shows the interior of a house of prostitution in Barcelona, Spain. Five female nudes, two with faces that resemble African masks, stand in a shallow space in front of a curtain. Picasso communicated a psychologically tense experience through crude brushwork and deliberate distortions of drawing and perspective.

From 1909 to the outbreak of World War I in 1914, Picasso and Georges Braque established the basic images and artistic principles that resulted in the birth and development of cubism. Other cubist painters included Juan Gris of Spain and Fernand Léger of France.



Österreichische Galerie, Vienna, Austria (Erich Lessing, Art Resource)

Judith with the Head of Holofernes
by Gustav Klimt
1901. Oil on canvas. 33 by 16½ in. (84 by 42 cm).



The Museum of Modern Art, New York City, Gift of Nelson A. Rockefeller in honor of Alfred H. Barr, Jr.

The Dance I by Henri Matisse
1909. Oil on canvas. 8 ft. 6 $\frac{1}{2}$ in. by 12 ft. 9 $\frac{1}{2}$ in. (2.60 by 3.90 m).



The Solomon R. Guggenheim Museum, New York City (photography by Lee B. Ewing, © The Solomon R. Guggenheim Foundation)

Violin and Palette by Georges Braque
1909. Oil on canvas.
38 $\frac{1}{8}$ by 16 $\frac{7}{8}$ in. (92 by 43 cm).

Cubism was not so much an art of cubes as of planes. The artist assembled these planes from multiple perspectives that present the many aspects of a subject all at once. In Braque's *Violin and Palette* (this page), the forms of a violin and an artist's palette are displayed as though the viewer were looking at them from many different perspectives at once. The forms melt into one another, discouraging the eye from resting on any one part of the canvas. This early phase of cubism is called *analytic cubism.* The goal of analytic cubism was to examine form and matter, to break them down into their essential elements, and then to reassemble them in a new way. Another example is Braque's *Man with a Guitar,* which appears in the **Cubism** article.

Primarily, Picasso wanted to collect the objects of everyday life and reassemble them in a nontraditional manner that would shock and disturb the viewer. This new way of depicting commonplace subject matter developed even more intensively during the second stage of Picasso's and Braque's cubist work from 1912 to 1914. This period saw the birth of *synthetic cubism,* in which the artist accumulated a range of purely pictorial elements and combined them to create a new form. Such elements typically consisted of everyday materials, such as pieces of newspaper and bottle labels. Picasso and Braque adopted nontraditional methods to construct their cubist images. One popular method was *collage,* in which the artist glued bits of paper and other materials onto the painting. An example of collage is Juan Gris's *The Bottle of Banyuls,* which appears in the **Cubism** article.

Cubism was hailed throughout the world as a symbol for all that was truly advanced and modern in art. For years, all kinds of modern painting were labeled *cubist* simply because they did not concern themselves with representing real objects in the external world.

Expressionism was a movement in the early 1900's that emphasized strong emotional content. Like the romantic movement of the 1800's, expressionism valued personal vision and spiritual revelation. Matisse's use of color to evoke feelings in the viewer is a type of expressionism. His use of color connected him with artists of the previous generation such as Vincent van Gogh and Edvard Munch. All three artists were influential figures in Germany during the early 1900's, where expressionism developed.

What is usually called *German expressionism* consists of two groups of artists who worked in Germany between 1905 and 1914. One was called *Die Brücke* (The Bridge), and the other was *Der Blaue Reiter* (The Blue Rider).

The Bridge group formed in 1905 in Dresden. It gained its name from the group's goal of bridging all the revolutionary elements of culture. The Bridge conceived of itself as both a return to the cooperative craft guilds of the Middle Ages and as a modern approach to making art. The Bridge artists included Ernst Ludwig Kirchner, Karl Schmidt-Rottluff, Erich Heckel, and Emil Nolde. These artists sought to be honest, direct, and interested in spiritual things. They were influenced by the Fauves as well as the art of African peoples, Pacific Islanders, and American Indians.

Kirchner was the leader of The Bridge. His painting is typical of the group's work in its combination of height-



© The Museum of Modern Art, New York City

Street, Dresden
by Ernst Ludwig Kirchner
1908. Oil on canvas.
4 ft. 11 $\frac{1}{4}$ in. by 6 ft. 6 $\frac{7}{8}$ in.
(1.5 by 2 m).

ened emotional intensity, symbolism, and decorative patterns. Kirchner's *Friedrichstrasse, Berlin* shows a dependency on French art in the choice of color and composition. However, the picture contains an emotional vitality characteristic of German expressionism. *Friedrichstrasse, Berlin* appears in the **Expressionism** article.

Another painting by Kirchner, *Street, Dresden* (this page) is a further example of the emotional intensity of the German expressionist style. Kirchner employed jarring contrasts of color, jagged brushstrokes, and deliberate distortion of the figures. These elements combine to achieve a new and transformed vision of the subject matter.

While The Bridge developed in Dresden, another highly influential movement of German painting developed in 1911 in Munich in The Blue Rider. The artists in the group included the Russian-born Wassily Kandinsky, Gabriele Münter, Franz Marc, and the American-born Lyonel Feininger. The Bridge sought to evoke emotional intensity through distorted figures and thick paint. The artists who formed the Blue Rider movement stressed the spiritual and symbolic properties of both natural and abstract forms.

The artistic goals of The Blue Rider artists involved expressing a general disillusionment with the values of society. The group sought a marriage of spiritual and symbolic values in nature. Franz Marc used animal themes. In his painting *The Large Blue Horses,* Marc tried to portray his religious feelings through animal forms. For Marc, the animals he depicted were heroic alternatives to what he believed were the spiritually weakened men and women of his society. *The Large Blue Horses* appears in **Germany** (Arts).

Wassily Kandinsky was the guiding personality of The Blue Rider. He spent several years before 1911 painting works filled with vivid colors influenced by the Fauves. Gradually, Kandinsky's works became abstract. He created an artistic vocabulary of forms and colors that are expressive but do not refer to anything in the physical world. In his *Black Lines* (page 80), there is no longer any form that viewers can recognize as resembling objects in the external world. This type of work is called *nonobjective.* Another example of this artist's nonobjective style, titled *Calm, No. 357,* appears in the **Kandinsky, Wassily** article.

Nonobjective painting in Russia. Perhaps the most durable legacy of cubism was its impact on entirely nonobjective art. Such art first appeared between 1910 and 1920, mainly in Russia and then the Netherlands. Russia's Kandinsky had been the first artist to introduce a completely nonobjective style. With the beginning of World War I in 1914, Kandinsky left Germany and returned to Russia, bringing the most advanced ideas from Western Europe with him.

The prewar period in Russia is notable for the number and quality of women painters. Natalia Goncharova worked closely with artist Mikhail Larionov in a style they called *rayonism.* It developed as a colorful, highly personal version of cubism, but one that remained largely abstract. Liubov Popova was a Russian cubist who worked in France during the prewar years and became one of the strongest followers of Picasso and Braque. Her cubist paintings were more dramatic and energetic than the French version.

Kasimir Malevich became a leader of Russian nonobjective art. He found what he believed was the logical and inevitable conclusion toward which European art was moving. "I fled to the form of the Square," Malevich wrote, "to free art from the [weight] of the objective world."

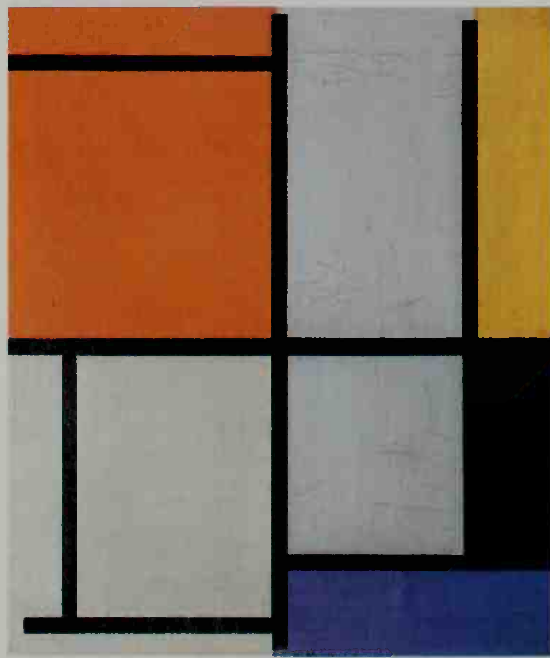
Malevich's focus on the square resulted in a style called *suprematism.* Malevich's paintings assemble



The Solomon R. Guggenheim Museum, New York City (photography by David Heald, © The Solomon R. Guggenheim Foundation)

Black Lines by Wassily Kandinsky
1913. Oil on canvas. 51 by 51 ⅝ in. (130 by 131 cm).

plane forms together to create floating images. In one painting from his *Suprematist Painting* series (page 81), a black rectangle is poised over a red rectangle. For Malevich, four-sided figures represented the most profound images in art. Malevich believed such shapes replaced the commonplace objects of the everyday world to form an artistic "blueprint" for an ideal world and for superior expression.



Kunstmuseum, Basel, Switzerland

Composition by Piet Mondrian
1921. Oil on canvas. 19½ by 16½ in. (50 by 42 cm).

Malevich's purely geometric abstract style was at the heart of a nonobjective art movement that swept westward from Russia after World War I ended in 1918. It combined with the principles of a Dutch group called *De Stijl* to influence generations of artists throughout the remainder of the 1900's.

De Stijl (*The Style*) developed in the Netherlands at the same time as Russian nonobjective art and worked toward the same conclusions. Like the Russian artists, artists in De Stijl tried to produce a legitimate response to the chaos of World War I. The primary spokesperson for the movement was Piet Mondrian. Like many artists of his time, he spent several years in Paris absorbing the lessons of cubism. Mondrian returned to the Netherlands briefly during the war. There he met fellow painters Theo van Doesburg and Bart van der Leck, with whom he formed De Stijl. Architect J. J. P. Oud and designer Gerrit Rietveld joined later.

De Stijl sought the collaboration of artists in the related fields of painting, sculpture, architecture, and industrial and graphic design. The movement emphasized the need for "abstraction and simplification." Almost immediately, De Stijl painters began exhibiting simplified compositions in the form of rectangles and straight lines. They restricted their palette to the primary colors of red, blue, and yellow.

Under the influence of De Stijl, Mondrian's painting was transformed from the cubism he had practiced in Paris into a style much tighter and more geometric. In *Composition* (this page), he typically limited his palette to a few bright colors plus black and white. His forms consist of squares, rectangles, and horizontal or vertical bands of black. With such works, Mondrian made the artistic statement that paintings were no longer "windows" to another world. Instead, they were physical objects subject to the same design principles as a house or a chair.

In *Composition,* Mondrian removed the depth-producing devices that even the cubists used, such as shading, modeling, and perspective. In this painting, Mondrian was no longer concerned with producing the illusion of depth. His composition forces the eye to move from side to side, from the center of the canvas to the edge.

Dadaism. In the years following World War I, many artists saw even cubism as too tame and too rational for a world left in turmoil by the war's destruction. The movement called *dada* was born in Zurich, Switzerland, though it later flourished in New York City and Paris. The dada movement was an expression of irrationality directed at a world the dadaists believed had lost all reason and concern for human values. Yet, through its self-imposed irrationality, dada opened a new world of creative impulse. It developed guidelines that would encourage the use of chance occurrences and the conscious mind in creating art. Early members of the group included Jean Arp and Marcel Janco.

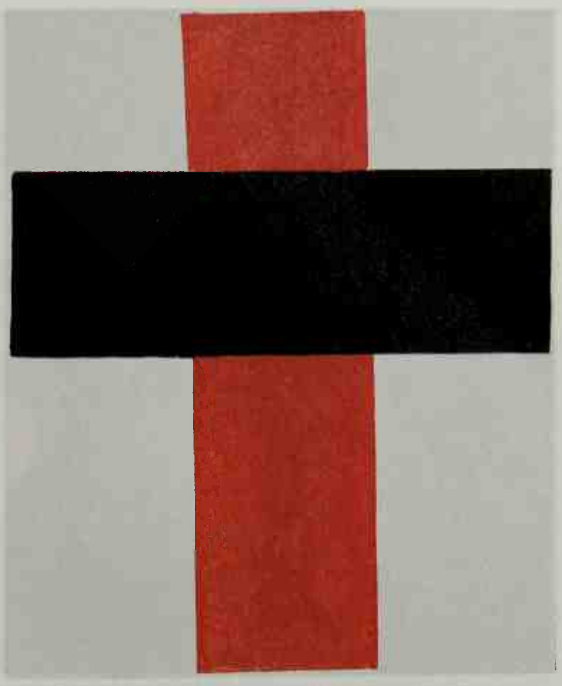
Dada originated in 1916 in the Cabaret Voltaire in Zurich. The members of the group selected the word randomly from a French dictionary. Early in its history, dada was primarily a literary movement in which poetry was created from a random selection of words. To create a dada work of art, Arp used a similar technique. He placed torn pieces of paper into a box, and after

shaking the box, he allowed the scraps to spill out onto a sheet of paper. He then pasted the pieces down according to the pattern in which they fell. He allowed randomness and chance to dictate the final composition of the picture.

Arp's German colleague Kurt Schwitters also adopted an unconventional approach to making art. Schwitters's work developed out of the synthetic cubism style, but he was even more aggressive in incorporating everyday objects into his works. Schwitters's *Merz Drawing* appears in the **Collage** article. Schwitters incorporated actual trash, including a button and a used envelope, in this composition. By using identifiable rubbish, Schwitters raised questions about the difference between art and nonart.

Surrealism. The artists who became the surrealists gathered around poet André Breton in Paris in the 1920's. The first Surrealist Manifesto was published in 1924, declaring the artistic goals of the organization, especially as conceived by Breton. For Breton, surrealism was a creative method that employed many of the ideas of Sigmund Freud, the Austrian physician who developed psychoanalysis as a method of treating mental illness. The basic strategy for Breton was *automatism,* a process for tapping the unconscious by writing in a trancelike state and recording the involuntary images that emerged. Taking his cue from the writings of Freud, Breton believed that dreams were the natural expression of the unconscious mind. Automatism, irrational thought associations, hallucinations, and the recollection of dream images offered a way to liberate the creative mind from the bonds of logic and reason.

Surrealism, like dada, began primarily as a literary movement. However, artists did organize themselves under the name of surrealism and staged a series of exhibitions. Gradually, the artists moved away from the influence of Breton and developed a broader appeal to artists and viewers alike.



Stedelijk Museum, Amsterdam, the Netherlands

Suprematist Painting (black and red cross) by Kasimir Malevich
1921-1927. Oil on canvas. 33 by 27 3/8 in. (84 by 70 cm).

Two branches of surrealist painting developed in Paris in the mid-1920's. *Abstract surrealism* included the work of André Masson of France and Joan Miró of Spain. *Illusionistic surrealism* included the work of Salvador Dali of Spain, Max Ernst of Germany, Yves Tanguy of France, and Paul Delvaux and René Magritte of Belgium.



Albright-Knox Art Gallery, Buffalo, New York



Carnival of Harlequin
by Joan Miró
1925. Oil on canvas.
26 by 36 5/8 in.
(66 by 93 cm).



The Metropolitan Museum of Art, New York City, Alfred Stieglitz Collection

Black Iris by Georgia O'Keeffe

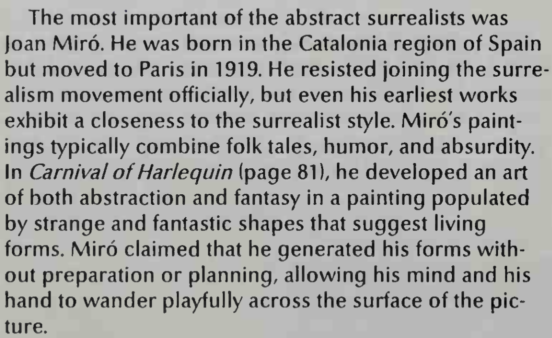
1926. Oil on canvas. 36 by 29 7/8 in. (91 by 76 cm).



Whitney Museum of American Art, New York City (photography by Sheldon C. Collins)

My Egypt by Charles Demuth

1927. Oil on composition board. 35 3/4 by 30 in. (91 by 76 cm).



The most important of the abstract surrealists was Joan Miró. He was born in the Catalonia region of Spain but moved to Paris in 1919. He resisted joining the surrealism movement officially, but even his earliest works exhibit a closeness to the surrealist style. Miró's paintings typically combine folk tales, humor, and absurdity. In *Carnival of Harlequin* (page 81), he developed an art of both abstraction and fantasy in a painting populated by strange and fantastic shapes that suggest living forms. Miró claimed that he generated his forms without preparation or planning, allowing his mind and his hand to wander playfully across the surface of the picture.

The work of the illusionistic surrealists contains highly realistic representations of dream states or hallucinations. Salvador Dali's *The Persistence of Memory* (page 84) is an example of what the artist called "hand-painted dream photographs." Works like these brought a new level of realism to painting. The illusionistic surrealists believed that realism, if pressed to extreme detail, could undercut the viewer's sense of reality, resulting in something almost ridiculous. There is a theatrical flavor to these works, particularly in Dali's paintings, where watches droop and a jellyfish walks on the land. The illusionistic surrealists hoped that by demonstrating the absurdity they saw in worldly existence they could awaken others to the irrational within themselves.

With the outbreak of World War II in 1939, many surrealist artists immigrated to New York City. This influx of European artists to the United States proved to be an enormous inspiration to young American artists, who suddenly found themselves in the company of great European masters. For other examples of surrealism, see **Dali, Salvador; Miró, Joan; Surrealism.**

The 1900's in North America

The new approaches to painting that developed in Europe did not make a great impact in the United States during the first years of the 1900's. Continuing a tradition developed after the end of the American Civil War in 1865, ambitious American artists went to Europe for advanced academic training. Lacking a strong artistic tradition in the United States, these artists relied upon Europe for inspiration as well as education.

Stieglitz and "291." The individual most responsible for bringing new styles of painting to the United States was photographer Alfred Stieglitz. He became the leader of the *Photo-Secession* movement, which championed photography as an art form. In furthering the movement's aims, he opened a gallery in New York City. It was located at 291 Fifth Avenue and was commonly called "291."

Stieglitz exhibited more than photographs at "291." The gallery became the first in the United States to exhibit paintings by such European masters as Cézanne, Matisse, and Picasso. Gradually, Stieglitz became less interested in European art and more concerned with establishing a new art movement on American soil. He provided an exhibition space for several young American artists. He supported these artists not only by exhibiting and selling their work, but also by providing encouragement, reviews, and publicity. The artists Stieglitz exhibited at "291" included such important American painters as Charles Demuth, Arthur Dove, Marsden Hartley, and Georgia O'Keeffe.

Precisionism was the first new style of the 1900's to emerge in the United States. It originated in the 1920's with Charles Demuth and Charles Sheeler as its leaders.

Precisionism merged with cubism and realism into a distinctly American style. Precisionism eliminated the complexities of analytic cubism but made something more abstract and angular of its realistic themes. The subject matter of precisionist painting consisted largely of views of the buildings and industrial structures typical of the American landscape. For example, Demuth's *My Egypt* (page 82) portrays a grain elevator in Lancaster, Pennsylvania.

Georgia O'Keeffe came to represent the new American approach to art. O'Keeffe, who was married to Alfred Stieglitz, spent her career painting particularly American subjects in realistic detail. She created dozens of abstract paintings, but she is perhaps best known for her carefully observed paintings of simple objects, such as shells, rocks, and flowers. In such works as *Black Iris* (page 82), O'Keeffe combined precise observation with a keen sense of design.

Regionalism. Stieglitz and such artists as Demuth and O'Keeffe were important because they forged a unique American identity out of European art of the 1900's. But some American artists rejected the art principles of Europe in favor of a vision of homespun Americanism. In the late 1920's, many American artists became strongly anti-European. They developed an approach to painting called *regionalism.*

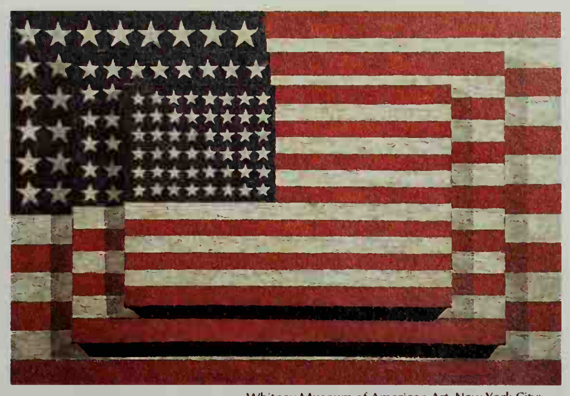
Regionalism was a movement that sought to glorify traditional American values in art, especially those of the rural Midwest. The movement insisted above all on the rejection of European ideas. Key artists in the regional movement included Thomas Hart Benton; Grant Wood; and John Steuart Curry.

During the 1930's, Benton attempted to move the center of the American art world away from New York City to the heartland of the country, the Midwest. Benton and other regionalists cultivated a nostalgic interest in the local scenes of American life that were disappearing. As the spokesperson for regionalism, Benton attacked European art and the international character of New York-based artists, especially those associated with Alfred Stieglitz.

To counteract European art, Benton developed a monumental style that found its expression in many large murals in public buildings. Benton's mature style can be seen in murals he painted for the State Capitol in Jefferson City, Missouri, in 1936. An example appears in **Western frontier life in America** (Law and order). In such works, Benton referred to Renaissance painting for stylistic influences. His figures, with their bulging, muscular bodies, resemble those seen in the paintings by Michelangelo.

Grant Wood received art training in Paris during the early 1920's. On a trip to Germany in 1928, he discovered the works of Flemish and German artists of the 1400's that inspired him to return to realism. Wood was soon producing paintings that combined ease of understanding with an unassuming charm. Wood's *American Gothic* (this page) is perhaps the most famous of all regionalist paintings. It transcends the seriousness of most regionalist art in favor of a delicate humor. The humor comes from Wood's placement of a typical American farmer and his daughter with European Gothic-style windows in the background.

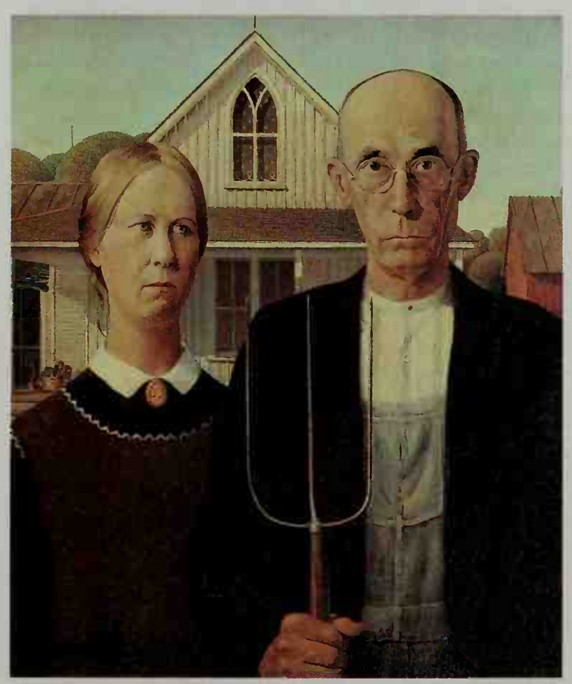
Like Benton and Wood, Curry gained recognition for painting scenes of Midwestern life, such as a religious baptism and a farm family fleeing an approaching tornado. For an example of his work, see the article **Curry, John Steuart.**



Three Flags by Jasper Johns
1958. Encaustic on canvas. 30 7/8 by 45 1/2 in. (78 by 116 cm).

Modern Mexican painting. There were two major challenges to the regionalist hold on American painting during the 1930's and 1940's. The first came from the arrival of mural painters from Mexico.

The Mexican muralists were Diego Rivera, José Orozco, and David Siqueiros. Rivera, perhaps the best known of the three, received several major mural commissions in the United States during the 1930's. His most significant commission was the *Detroit Industry* murals executed at the Detroit Institute of Arts.



American Gothic by Grant Wood
1930. Oil on beaverboard. 29 7/8 by 24 7/8 in. (76 by 63 cm).



The Museum of Modern Art, New York City

The Persistence of Memory
by Salvador Dali
1931. Oil on canvas.
9 ½ by 13 in. (24 by 33 cm).

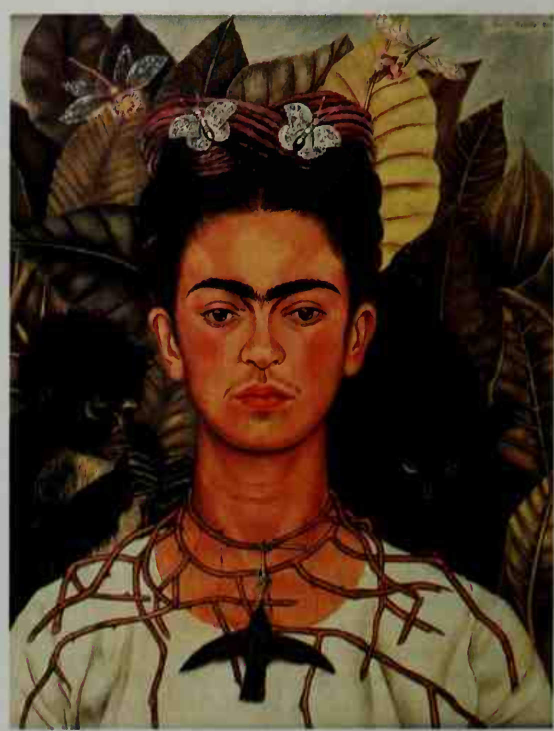
Rivera worked toward creating a national Mexican style that reflected the history of the Mexican people as well as the socialist spirit of the Mexican Revolution of the early 1900's. Rivera's mural style influenced artists in both Mexico and the United States. It combined decorative folklore elements of the Mexican art tradition with dramatic realism.

Another influential Mexican painter of the 1930's was Frida Kahlo, who was married to Diego Rivera. Kahlo's paintings were largely autobiographical in subject matter. She produced many self-portraits depicting herself in different psychological states. Stylistically, she was interested in the kinds of heroic representation produced by her husband. However, more than Rivera, she was firmly rooted in the traditions of Mexico and almost always portrayed herself in traditional Mexican costumes. Her subject matter is also concerned with traditional Mexican culture. In *Self-Portrait with Thorn Necklace and Hummingbird* (this page), Kahlo wears a thorn necklace that draws blood from her neck, referring to the ritual bloodletting practiced by Aztec priests in ancient Mexico. For other examples of Mexican painting, see **Aztec; Indian, American** (introduction); **Latin America** (The arts); **Mexico** (Arts); **Orozco, José Clemente; Rivera, Diego.**

Europeans in America. The second major challenge to regionalism came from the arrival of many leading European artists who settled as refugees in the United States during World War II. One such artist was Piet Mondrian, who arrived in New York City in 1940 and died there in 1944. Most of the important surrealists also came to the United States. They included André Breton, Max Ernst, Yves Tanguy, and André Masson, as well as Marcel Duchamp, who was close to both the surrealists and dadaists.

With the presence of many European painters, as well as Mexican muralists, New York City became a painting center unsurpassed anywhere in the world. The presence of so many important artists provided a framework for the formation of a new American style. The Europeans were a powerful influence on the first important American art movement of the postwar period, abstract expressionism.

Abstract expressionism was a loosely organized movement. The pictures of the abstract expressionists



Harry Ransom Humanities Research Center, University of Texas, Austin, Texas

Self-Portrait with Thorn Necklace and Hummingbird
by Frida Kahlo
1940. Oil on board. 24 ½ by 18 ¾ in. (62 by 48 cm).

did not resemble one another's in most cases, but they all shared a desire to create an important American tradition of painting. Although the abstract expressionists developed diverse styles, they still worked to make something genuinely expressive from the abstract tradition they inherited from Europe.

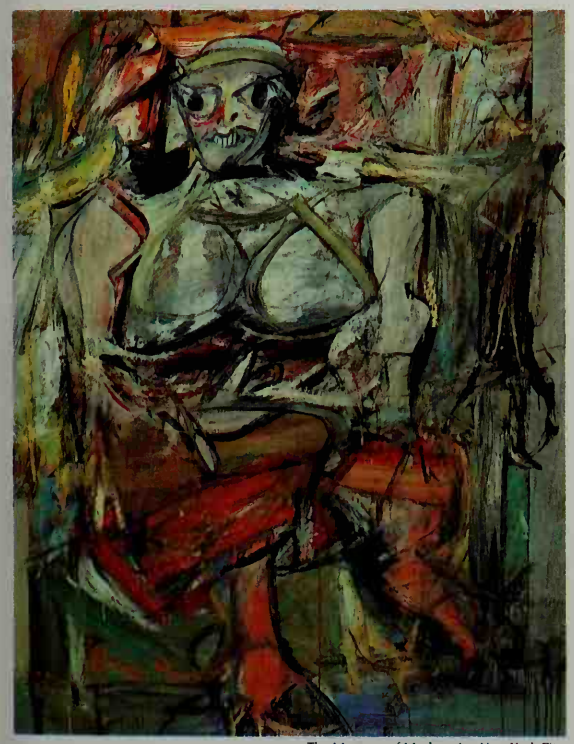
One of the first artists to develop in the 1940's was the Dutch-born Willem de Kooning. Although most of his colleagues painted in a totally abstract style, de Kooning was one of the most persistent in maintaining the human figure in his work. He began to exhibit a series of paintings that depict full-bodied, wide-eyed, toothy women who loom in large, abstract space. The most famous of this series is *Woman, I* (this page). De Kooning constructed the pictures in layers of thick paint, applied with an urgent, even violent feeling. Many viewers were offended by the images of the women, while others were moved by their vitality. By the mid-1950's, de Kooning was painting totally abstract pictures full of lush, thick paint. An example, *Easter Monday,* appears in the article **De Kooning, Willem**.

Perhaps the most renowned of the abstract expressionist painters was Jackson Pollock. Pollock radically altered the traditional techniques of painting when he poured his paint onto canvases that were tacked to the floor. The results were compositions made up of tangles of poured paint. The lines formed by the fluid reflected the movements of the artist's arm as he dripped the paint onto the canvas. Pollock produced several mural-sized canvases filled with dense, dripping lines that became a kind of automatic writing related to the technique that was practiced by the surrealists. The character of each of Pollock's "drip" paintings differs in their patterns, rhythms, densities, and textures. An example of a Pollock painting appears in **United States** (The arts).

In general, the early abstract expressionists favored untraditional materials applied in new ways. For example, both Pollock and de Kooning used car enamels and house paints when they wanted their paintings to have an especially raw look.

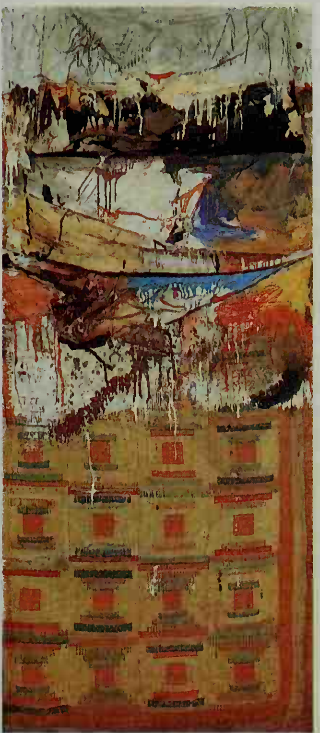
The quickness and energy of de Kooning's brushstrokes and Pollock's drip paintings are evident in the finished works, leading to the term *action painting* to describe the painting process. Another group of abstract expressionists emerged later than the action painters. They were called *field painters* and included Barnett Newman, Mark Rothko, and Clyfford Still.

Newman painted large canvases that often consist of one strong color, sometimes divided by horizontal or vertical stripes. Rothko eliminated subject matter in his paintings around 1947 and adopted washes of color that seem to drift across the canvas. For Rothko, color takes over for the gestures of Pollock and de Kooning in works like *Number 8,* which appears in the article **Rothko, Mark**. Rothko meant his paintings to be perceived at once, as a whole. Similar concerns can be seen in Clyfford Still's work. Still's expanses of color are less transparent than Rothko's. Instead, Still constructed his paintings from thickly applied paint. The compositions evoke images of prehistoric landscapes. Areas of color



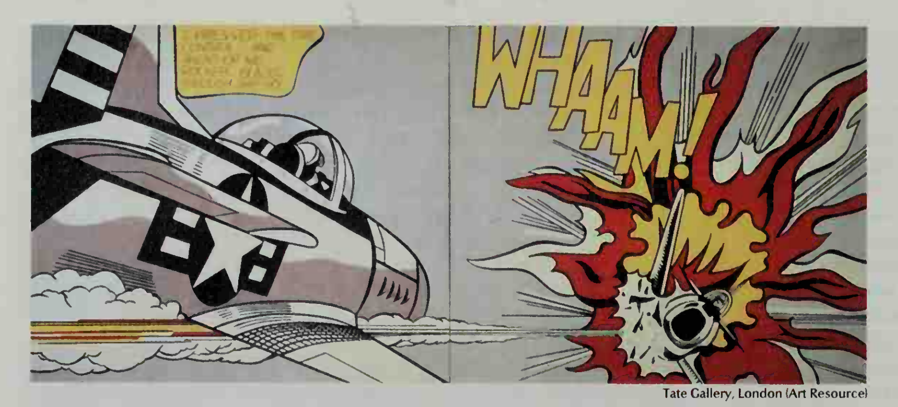
The Museum of Modern Art, New York City

Woman, I by Willem de Kooning
1952. Oil on canvas. 6 ft. 3 $\frac{7}{8}$ in. by 4 ft. 10 in. (1.93 by 1.47 m).



The Museum of Modern Art, New York City; © 1995 Robert Rauschenberg/Licensed by VAGA, New York, NY

Bed by Robert Rauschenberg
1955. Oil and pencil on pillow, sheet, and quilt with wood support. 6 ft. 3 $\frac{1}{4}$ in. by 2 ft. 7 in. (191 by 79 cm).



Tate Gallery, London (Art Resource)

Whaam! by Roy Lichtenstein
1963. Acrylic on canvas.
5 ft. 8 in. by 13 ft. 4 in.
(1.73 by 4.06 m).

are joined with craggy fissures of paint that lend themselves to symbolic associations with the earth and its textures. For other examples of abstract expressionist painting, see **Abstract expressionism; Gorky, Arshile; Motherwell, Robert; Tomlin, Bradley Walker.**

Color-field painting. A group of artists emerged during the 1950's and 1960's who moved away from both subject matter and the outward emotionalism found in abstract expressionism. They tried to reduce painting to the purity of color on a flat plane. These artists became known as *color-field painters* and included Helen Frankenthaler, Morris Louis, Kenneth Noland, and Jules Olitski.

The color-field painters abandoned the brush marks that had been so vital to many abstract expressionists. Instead, they introduced a technique in which thinned paint was poured onto unprimed canvas and allowed to soak into the canvas in abstract designs. Helen Frankenthaler was the first artist to use this technique effectively in her landmark painting *Mountains and Sea* (page 29). Frankenthaler was influenced by the poured paintings of Jackson Pollock. She attempted to work automatically as Pollock had done, capitalizing on accidents and spills to create the painting's composition.

Morris Louis and Kenneth Noland saw *Mountains and Sea* almost immediately after its completion and began experimenting with the same technique. They were soon producing mural-sized paintings filled with translucent color. Their works eliminated subject matter and drawing in favor of pure color.

The revival of subject matter. During the postwar period, some artists tried to restore subject matter to painting. During the mid-1950's, Robert Rauschenberg and Jasper Johns believed that art could be changed through addition rather than reduction. To this end, they adopted the collage technique, adding paper, cloth, and other objects to the surface of their canvases. Gradually, the work became more sculptural. Objects as diverse as stuffed birds and inflated tires became part of their art. Both Rauschenberg and Johns looked to the work of dada artists, such as Kurt Schwitters, as a model for creating their work.

In Rauschenberg's *Bed* (page 85), the artist combined sheets, a pillow, and a quilt as the components of his construction. He forced the cloth elements to function as a kind of canvas as he smeared the surface with paint. This type of construction has been called an *assemblage,* referring to the act of gathering materials and combining them to build images. See **Rauschenberg, Robert** (picture).

Jasper Johns produced assemblages, but he is perhaps best known for his paintings of flags, targets, and numbers. In *Three Flags* (page 83), Johns precisely painted a version of the American flag. He executed *Three Flags* through the difficult medium of encaustic, in which the colors are mixed with wax and heated. Johns attached no meaning to his flag, claiming that it was the most basic design he could find to paint. Like Rauschenberg, however, Johns was searching for a new content for painting, one that could not be accused of sentimentality or storytelling.

Pop art. The work of Rauschenberg and Johns became enormously important in the development of pop art during the 1960's. Pop art took its themes from subjects not previously associated with fine art. These subjects included comic strips, motion pictures, and especially advertising and other types of commercial art. The chief pop artists were Jim Dine, Roy Lichtenstein, James Rosenquist, and Andy Warhol.

Pop art challenged the fine arts tradition in more than just its subject matter. Pop artists used many of the techniques of commercial artists to achieve new effects. For example, in many of his paintings, Lichtenstein used tiny *benday* dots of color he created with a perforated metal screen and a toothbrush. Benday dots make up the images in color comics. The dots are used in the right half of Lichtenstein's *Whaam!* (this page).

Many viewers considered pop art to be playful and trivial. However, pop artists were serious about their work. They rejected the sense of superiority they saw in postwar abstraction and favored an art that would appeal to a broader segment of society.

Andy Warhol exploited commercial silk-screen techniques, making paintings by forcing ink or paint through a piece of silk onto canvas. The silk-screen process allowed Warhol to use any available printed image as a source for his painting. Additionally, with the silk-screen, Warhol could reproduce his images over and over in virtually identical copies. In the *Marilyn Monroe Diptych,* which appears in the article **Warhol, Andy,** he used the same screen to repeat the movie star's image across the length of the canvas. He could also use the same screen to reproduce additional canvases. Many of Warhol's works were multiple images of newspaper photos, soup cans, and automobile accidents. For other examples of pop art, see **Oldenburg, Claes; Pop art.**

Minimal art was an abstract style that appeared particularly in the United States during the 1960's. Minimal painters such as Agnes Martin and Frank Stella concentrated on color, line, and shape. Most minimal works have a unified composition and emphasize geometric abstraction. An example appears in the article **Stella, Frank.**

New image painting. In 1978, the Whitney Museum of American Art in New York City presented a group of artists in an exhibition called "New Image Painting." The new imagists included Jennifer Bartlett, Neil Jenney, and Susan Rothenberg. The group shared a revived interest in *figurative painting,* which depicts human figures and other recognizable subjects. They believed in the potential of painting that was more openly communicative than the styles that had preceded them.

Susan Rothenberg painted canvases that combined an interest in figurative subject matter with an interest in the more formal properties of design. In the mid-1970's, the flat silhouette of a horse appeared in her paintings. Eventually, the horse yielded to the human figure in her work. In her later paintings, Rothenberg's figures float in a submarine world of fluid brushwork, the figures silhouetted against shimmering luminous paint. An example of this phase of her work is *Mondrian Dancing* (page 88).



Whitney Museum of American Art, New York City (Estate of Jean-Michel Basquiat, © 1983. Used by permission. Photography by Bill Jacobson Studio)

Hollywood Africans by Jean-Michel Basquiat
1983. Acrylic and mixed media on canvas.
84 by 84 in. (213 by 213 cm).

Recent painting

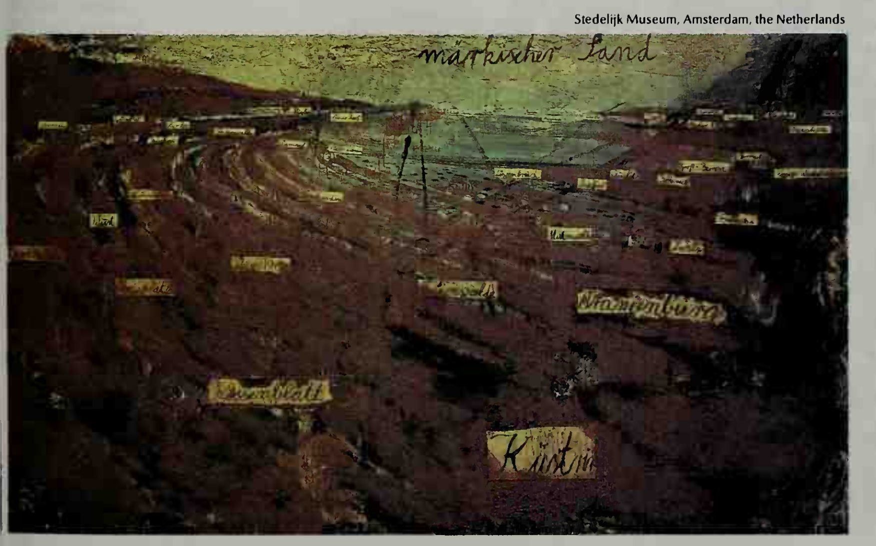
The new image painters set the stage for explosive developments in painting during the 1980's. Much of the important new painting developed in Europe.

Neoexpressionism. German artists were in the lead in reviving the technique of painting. The works of Anselm Kiefer and Georg Baselitz showed a new tendency toward expressionism. By 1980, their paintings were referred to as *neoexpressionism.* The term since has been broadened to include works by American, British, and Italian artists.

Neoexpressionism in Germany showed the influence of The Bridge and The Blue Rider expressionist styles of the early 1900's. The neoexpressionists were also influenced by abstract expressionism. The best known of the German painters is Kiefer. He has produced paintings in which he explores memories of Nazi Germany and of the Holocaust, the mass murder of European Jews by the Nazis. Kiefer also went back into art history, incorporating elements of the art of Caspar David Friedrich, French sculptor Auguste Rodin, and Vincent van Gogh. Kiefer almost single-handedly revived an interest in German romantic painting, creating works on a large physical scale.

Kiefer painted several symbolic landscapes, such as *Märkischer Sand* (*March Sand*), shown on this page. In this work, Kiefer presents a vast panoramic field with furrowed lines sweeping majestically toward the horizon. The field is labeled with the names of German towns. As if to emphasize the unchanging character of

Stedelijk Museum, Amsterdam, the Netherlands



Märkischer Sand
(March Sand)
by Anselm Kiefer
1982. Oil, paper, and sand on canvas.
10 ft. 10 in. by 18 ft. 3 in.
(3.30 by 5.56 m).



The St. Louis Art Museum, St. Louis, Missouri

Mondrian Dancing by Susan Rothenberg
1985. Oil on canvas. 4 ft. 1/4 in. by 7 ft. 7 in. (1.23 by 2.31 m).

the land, Kiefer mixed sand into the paint. He also added sand in other landscapes, as well as grass, straw, and twigs.

Baselitz paints upside-down figures that symbolically represent two sides of Germany, a country politically divided until 1990. More than Kiefer, Baselitz regards himself as an abstract painter. He believes that by turning his figures upside down, he has discharged them of their traditional subject matter, allowing the viewer to focus on the painterly brushwork.

Another German artist, Gerhard Richter, has worked in a broad variety of styles including neoexpressionism. Some of his paintings are richly colored abstractions, but he has also worked in a figurative style. Some of Richter's works combine painting with photography.

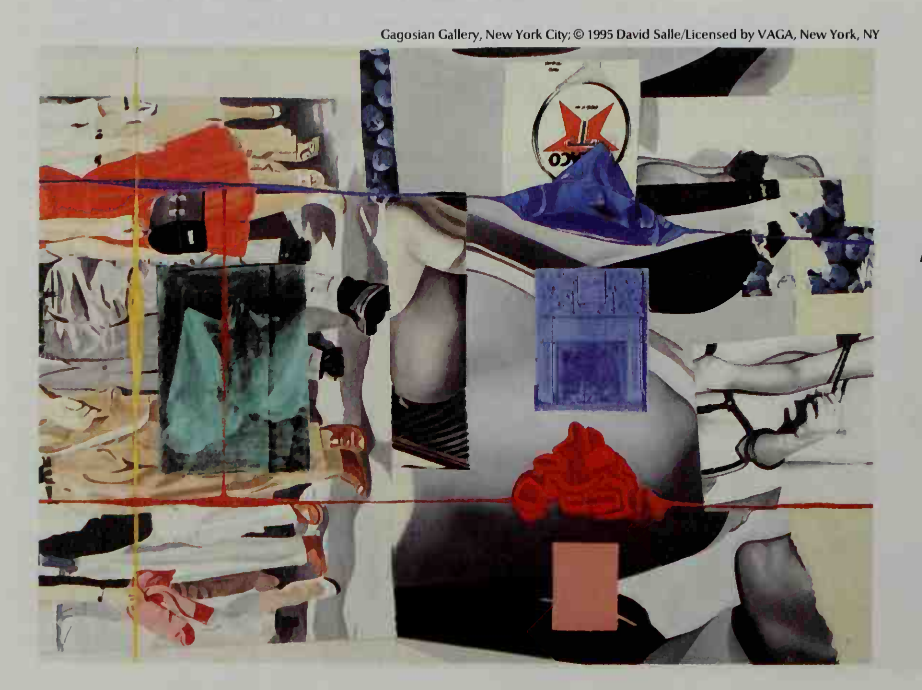
American versions of neoexpressionism have been far less political than the German variety. Such artists as Julian Schnabel and Jean-Michel Basquiat produced canvases that featured prominent brushwork meant to visually lure the viewer into the picture. Schnabel's work from the early 1980's emphasizes broken crockery that has been glued to the surface of the painting. These pieces of broken plates act as an extension of the brushstrokes, adding shape, color, and texture to the painting.

Basquiat's career straddled neoexpressionism and the *graffiti* movement. Graffiti artists, led by American artist Keith Haring, painted or scratched words or drawings on the walls of public places. Basquiat was born into a Haitian-Puerto Rican family, and the subject matter of his paintings reflects his cultural background. Basquiat began executing graffiti art on the street. Gradually, he began to work on canvases in which he combined many verbal signs—names, titles, phrases, and poetry—with an odd assortment of forms. These forms included masks and skulls, as well as cartoonlike figures that resembled robots. An example is his *Hollywood Africans* (page 87). Basquiat died at the age of 28, just as he was establishing himself as a mature artist.

Post-modernism. The theories of post-modernism had an impact on painting of the late 1900's. Post-modernism has so many meanings that a single definition is impossible. In general, post-modern art values communication as a primary goal, but it insists that understanding works of art is never clear or easy. Several painters explored post-modern ideas in their works, including the American artists Eric Fischl, Sherrie Levine, Robert Longo, and David Salle.

Fischl painted figurative works, many with disturbing sexual overtones. Longo paints modern urban themes. Levine gained prominence for her graphite and watercolor reproductions of the works of such modern masters as Kasimir Malevich and Piet Mondrian.

Gagosian Gallery, New York City; © 1995 David Salle/Licensed by VAGA, New York, NY



Picture Builder by David Salle
1993. Oil and acrylic on canvas.
7 ft. by 9 ft. 6 in. (2.13 by 2.90 m).

Salle's work uses different elements, both words and images, and combines them in surprising ways, as in *Picture Builder* (page 88). Salle allows his images to overlap, forcing the viewer to search for possible meanings and connections among the painting's visual elements.

Salle's art demonstrates the post-modern belief that any form of representation is valid. This belief allows the artist to comb through all the visual material in his or her world, increasing the potential for art to describe every possible experience. Ann Friedman, Valerie Lind Hedquist, Joseph F. Lamb, Vernon Hyde Minor, Michael Plante, Henry M. Sayre, Marilyn Stokstad, Elizabeth deS. Swinton, and Marjorie S. Venit

Related articles in *World Book*. See **Canada** (The arts); **United States** (The arts); and *The arts* section of many other country articles, such as **India** (The arts). Many of the following biographies include examples of the artist's work. Paintings also appear in many other articles. There are cross-references in the painters' biographies to these articles. For example, there are cross-references in the **Leonardo da Vinci** biography to his paintings in the articles **Jesus Christ** and **John the Baptist, Saint**.

Materials and techniques

Collage
Finger painting
Fresco
Mosaic
Mural
Paint
Sand painting
Stained glass

Asian painting

Bihzad, Kamal ad-Din
Chen Rong
Gu Kaizhi
Hiroshige
Hokusai
Huizong
Islamic art
Japanese print
Ma Yuan
Sesshu
Sharaku
Utamaro
Wang Wei
Wu Daozi

Medieval painting

Book of Kells
Byzantine art
Carolingian art
Cimabue, Giovanni
Duccio di Buoninsegna
Gothic art
Icon
Illuminated manuscript
Limbourg, Pol de
Simone Martini

Renaissance painting

The Italian Renaissance

Angelico, Fra
Bellini, Gentile
Bellini, Giovanni
Bellini, Jacopo
Botticelli, Sandro
Correggio
Ghirlandajo, Domenico
Giorgione
Giotto
Leonardo da Vinci
Lippi, Filippino
Lippi, Filippo
Mannerism
Mantegna, Andrea
Masaccio
Michelangelo
Piero della Francesca
Pollaiuolo, Antonio del
Raphael
Renaissance
Tintoretto
Titian
Uccello, Paolo
Verrocchio, Andrea del

The northern Renaissance

Bosch, Hieronymus
Bruegel, Pieter, the Elder
Campin, Robert
Cranach, Lucas, the Elder
Dürer, Albrecht
Grünewald, Matthias
Holbein, Hans, the Elder
Holbein, Hans, the Younger
Schongauer, Martin
Van der Goes, Hugo
Van der Weyden, Rogier
Van Eyck, Jan

The 1600's and 1700's

Baroque
Boucher, François
Caravaggio, Michelangelo Merisi da
Chardin, Jean Baptiste S.
Classicism
Claude
Colonial life in America (Painting)
Copley, John Singleton
David, Jacques Louis
De Hooch, Pieter
Feke, Robert
Fragonard, Jean Honoré
Gainsborough, Thomas
Gentileschi, Artemisia
Goya, Francisco
Greco, El
Hals, Frans
Hogarth, William
Kauffmann, Angelica
Leyster, Judith
Memling, Hans
Murillo, Bartolomé Esteban
Peale (family)
Poussin, Nicolas
Raeburn, Sir Henry
Rembrandt
Reynolds, Sir Joshua
Ribera, Jusepe de
Rococo
Rubens, Peter Paul
Ruisdael, Jacob van
Steen, Jan
Stuart, Gilbert Charles
Teniers, David, the Younger
Tiepolo, Giovanni Battista
Trumbull, John
Van Dyck, Sir Anthony
Velázquez, Diego
Vermeer, Jan
Veronese, Paolo
Vigée-Lebrun, Elisabeth
Watteau, Antoine
West, Benjamin
Zurbarán, Francisco de

The 1800's

Movements

Art nouveau
Barbizon School
Hudson River School
Impressionism
Postimpressionism
Pre-Raphaelite Brotherhood
Realism
Romanticism

North American painters

Allston, Washington
Bierstadt, Albert
Bingham, George Caleb
Blakelock, Ralph Albert
Catlin, George
Chase, William Merritt
Church, Frederick Edwin
Cole, Thomas
Eakins, Thomas
Harnett, William Michael
Harris, Robert
Hassam, Childe
Hicks, Edward
Homer, Winslow
Inness, George
Kane, Paul
Leutze, Emmanuel Gottlieb
Morse, Samuel Finley Breese
Pickett, Joseph
Remington, Frederic
Russell, Charles Marion
Ryder, Albert Pinkham
Sargent, John Singer
Sully, Thomas
Tanner, Henry Ossawa
Whistler, James Abbott McNeill

European painters

Blake, William
Bonheur, Rosa
Bonington, Richard Parkes
Bonnard, Pierre
Breton, Jules Adolphe
Burne-Jones, Sir Edward
Cassatt, Mary
Cézanne, Paul
Constable, John
Corot, Camille
Courbet, Gustave
Daumier, Honoré
Degas, Edgar
Delacroix, Eugène
Ensor, James
Gauguin, Paul
Géricault, Théodore
Ingres, Jean A. D.
Manet, Edouard
Millais, Sir John Everett
Millet, Jean François
Monet, Claude
Morisot, Berthe
Munch, Edvard
Pissarro, Camille
Renoir, Pierre Auguste
Rossetti, Dante Gabriel
Rousseau, Henri
Seurat, Georges
Sisley, Alfred
Toulouse-Lautrec, Henri de
Turner, J. M. W.
Van Gogh, Vincent
Vuillard, Edouard

The 1900's

Movements and styles

Abstract art
Abstract expressionism
Ashcan school
Bauhaus
Cubism
Dadaism
Expressionism
Fauves
Futurism
Group of Seven
Minimal art
Pop art
Postmodernism
Surrealism

American painters 1900-1945

Bellows, George Wesley
Benton, Thomas Hart
Burchfield, Charles Ephraim
Curry, John Steuart
Davies, Arthur Bowen
Davis, Stuart
Demuth, Charles
Dove, Arthur Garfield
Du Bois, Guy Pene
Feininger, Lyonel
Glackens, William
Graves, Morris
Hartley, Marsden
Henri, Robert
Hopper, Edward
La Farge, John
Lawson, Ernest
Lee, Doris Emrick
Luks, George Benjamin
Marin, John
Marsh, Reginald
Moses, Grandma
O'Keeffe, Georgia
Parrish, Maxfield
Pippin, Horace
Prendergast, Maurice Brazil
Ray, Man
Rockwell, Norman
Shahn, Ben
Sheeler, Charles
Shinn, Everett
Sloan, John
Soyer brothers
Tobey, Mark
Weber, Max
Wood, Grant

American painters after 1945

Albers, Josef
Bearden, Romare
Close, Chuck
De Kooning, Willem
Dine, Jim
Frankenthaler, Helen
Gorky, Arshile
Gottlieb, Adolph
Guston, Philip
Hofmann, Hans
Johns, Jasper
Kline, Franz
Lawrence, Jacob
Levine, Jack
Lichtenstein, Roy
Lindner, Richard
Mitchell, Joan
Motherwell, Robert
Newman, Barnett
Pollock, Jackson
Rattner, Abraham
Rauschenberg, Robert
Rivers, Larry
Rosenquist, James
Rothko, Mark
Stella, Frank
Still, Clyfford
Tomlin, Bradley Walker
Warhol, Andy
Wyeth, Andrew

Canadian painters

Carr, Emily
Jackson, Alexander Young
Milne, David B.
Thomson, Tom
Watson, Homer

European painters

Bacon, Francis
Balthus
Beckmann, Max
Boccioni, Umberto
Braque, Georges
Chagall, Marc
Chirico, Giorgio de
Dali, Salvador
Derain, André
Dubuffet, Jean
Duchamp, Marcel
Dufy, Raoul
Ernst, Max
Gris, Juan
Grosz, George
Hockney, David
Kandinsky, Wassily
Kiefer, Anselm
Klee, Paul
Klimt, Gustav
Kokoschka, Oskar
Kollwitz, Käthe
Laurencin, Marie
Léger, Fernand
Magritte, René
Malevich, Kasimir
Masson, André
Matisse, Henri
Miró, Joan
Modigliani, Amadeo
Mondrian, Piet
Nicholson, Ben
Pevsner, Antoine
Picasso, Pablo
Rouault, Georges
Schiele, Egon
Schwitters, Kurt
Utrillo, Maurice
Vlaminck, Maurice de

Mexican painters

Kahlo, Frida
Orozco, José Clemente
Rivera, Diego
Siqueiros, David
Tamayo, Rufino

Other related articles

Apelles
Art and the arts
Avant-garde
Calligraphy
Cartoon
Colonial life in America (Painting)
Design
Drawing
Folk art
Geometric style
Manuscript
Perspective

Article outline

I. What painters paint
A. People
B. Religious subjects
C. Landscapes and seascapes
D. Still-life paintings
E. History paintings
F. Mythology paintings
G. Social expression
H. Decoration
I. Abstract painting

II. The elements of painting
A. Color
B. Line
C. Mass
D. Space
E. Texture
F. Composition
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III. Materials and techniques
A. Pigments
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E. Grounds
F. Other materials
G. Encaustic painting
H. Fresco painting
I. Tempera
J. Oil painting
K. Pastel
L. Water-color painting
M. Synthetic resins

IV. Early painting
A. Prehistoric painting
B. Egyptian painting
C. Aegean painting
D. Greek painting
E. Etruscan painting
F. Roman painting

V. Asian painting
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B. Chinese painting
C. Japanese painting
D. Islamic painting

VI. Medieval painting
A. Historical background
B. Early Christian and Byzantine art
C. Early medieval painting in the West
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VII. The Renaissance
A. The 1300's
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VIII. The 1600's and 1700's
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C. The Dutch masters
D. The Spanish masters
E. Rococo painting
F. Neoclassicism

IX. The 1800's
A. Later neoclassicism
B. Romanticism
C. Art for a new public
D. Realism
E. The Pre-Raphaelite Brotherhood
F. Edouard Manet and the impressionists
G. New visual sources
H. Painting outside France

I. The art world, 1850-1900
J. Women artists
K. Postimpressionism
L. Symbolism
M. Legacy of the 1800's

X. The 1900's in Europe
A. The Fauves
B. Cubism
C. Expressionism
D. Nonobjective painting in Russia
E. De Stijl
F. Dadaism
G. Surrealism

XI. The 1900's in North America
A. Stieglitz and "291"
B. Precisionism
C. Georgia O'Keeffe
D. Regionalism
E. Modern Mexican painting
F. Europeans in America
G. Abstract expressionism
H. Color-field painting
I. The revival of subject matter
J. Pop art
K. Minimal art
L. New image painting

XII. Recent painting
A. Neoexpressionism
B. Postmodernism

Questions

What obstacles did women painters face during the 1800's?
How did Greek artists create *red-figure* paintings?
What are the main elements in abstract painting?
How did Alfred Stieglitz influence modern painting in the U.S.?
Who were the most important patrons of Dutch art in the 1600's?
How did the Yuan painters influence Chinese art?
What is the purpose of a *ground* in a painting?
What were the chief characteristics of Venetian painting during the Renaissance?
How does an artist use light and shade in a painting?
Who were the main Gothic painters?
How did Pop Art challenge the fine arts tradition?
What were some of the chief features of Neoexpressionism? Of Postmodernism?

Additional resources

Level I

Art and Artists. 6 vols. Thomson Learning, 1994-1995. Each volume covers a different period of art history.
Govignon, Brigitte, ed. *The Beginner's Guide to Art.* Abrams, 1998.
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Level II

Beckett, Wendy. *The Story of Painting.* 2nd ed. Dorling Kindersley, 2000.
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Paisley, *PAYZ lee,* is a town in western Scotland about 7 miles (11 kilometers) west of Glasgow. For location, see **Scotland** (political map). Paisley is the largest town in the Renfrew District, which has a population of 203,447. The town is known for the patterned shawls it produced during the 1800's. *Paisley* is also the name of the design that imitates the pattern used on these shawls. A. S. Mather

Paisley, Ian (1926-), is a Protestant minister and a political leader in Northern Ireland. He became known for his strong support of Northern Ireland's continued union with the United Kingdom.

Ian Richard Kyle Paisley was born in Armagh, Northern Ireland. He studied at Reformed Presbyterian Theological College in Belfast and was ordained a minister in 1946. Paisley founded the Free Presbyterian Church of Ulster in Belfast in 1951. He was elected to the British House of Commons in 1970. In 1971, he helped found the Democratic Unionist Party, which opposes the sharing of power with Roman Catholics in Northern Ireland. He became a member of the European Parliament in 1979.

Paisley was once imprisoned for urging followers to block a Catholic civil rights demonstration. He was ejected several times from the House of Commons and the European Parliament for his fiery outbursts. Paisley opposed the 1998 peace agreement that established a power-sharing legislative assembly for Northern Ireland. He was elected to the assembly in 1998 and vowed to block full implementation of the agreement.

Paul E. Gallis

Paiute Indians, *py YOOT,* is the name of two tribal groups of the western United States—the Northern Paiute and the Southern Paiute. About 8,000 Northern Paiute and about 1,800 Southern Paiute live on reservations, in federal colonies, and in many communities of Arizona, California, Nevada, Oregon, and Utah. The people work in agriculture, crafts, tourism, and various urban industries.

The Northern Paiute once lived in the area extending from Owens Lake in California, through Nevada, to just south of the Columbia River in Oregon. The Southern Paiute ranged from the Mojave Desert of California to the Colorado River in Arizona, and then north to central Utah. Small groups of Paiute moved about, hunting antelope, deer, mountain sheep, rabbits, and other game. These groups of Paiute also collected berries, nuts, roots, and seeds. The Northern Paiute who lived around the lakes and marshes of western Nevada earned their livelihood by fishing. Some Southern Paiute planted beans, corn, and squash.

The Paiute lived in cone-shaped houses made of brush. They wove baskets from grass, reeds, and willows. The Paiute religion centered around spirits of nature.

During the 1800's, the Northern Paiute fought white settlers who had come into the region. The Indians won an important victory at Pyramid Lake in Nevada in 1860. The Southern Paiute remained peaceful, though they were raided occasionally by the Ute and Navajo Indians, who sold them as slaves on the Mexican frontier. In the 1860's and the 1870's, the U.S. government established reservations for both groups of Paiute.

Catherine S. Fowler

See also **Winnemucca, Sarah**.



© Piers Benatar, Panos Pictures

Mountains cover much of Pakistan. The Chitral Valley, *shown here,* lies along the border with Afghanistan. Tirich Mir, the highest mountain in the Hindu Kush range, rises in the background.

Pakistan

Pakistan is a Muslim country in southern Asia officially called the Islamic Republic of Pakistan. Its capital is Islamabad, and its largest city is Karachi.

Almost all the people of Pakistan practice Islam, the Muslim religion. Despite their common religion, Pakistanis have strong ties to different cultures. The major cultural groups include Punjabis, Sindhis, Pashtuns (or Pakhtuns), and Baluchi. Each group speaks a different language and inhabits a different part of the country. Urdu is the official language of Pakistan, but less than 10 percent of the people speak it as their primary language. Pakistan has struggled to bring the different cultures together into a unified nation.

Pakistan's natural features are as diverse as its cultural groups—towering mountain ranges, high plateaus, lush green plains, and arid deserts. Most of the people live in the irrigated plains of eastern Pakistan. The most densely populated part is the Punjab, a rich agricultural region in the northeast. The western part of the country is sparsely populated because of its dry climate and its barren, rugged, mountainous terrain.

The majority of Pakistan's people live in rural areas, though Pakistan's cities are growing rapidly. Most of Pakistan's rural inhabitants work in agriculture and follow traditional clan and tribal customs. By contrast, people in the urban areas engage in a range of professions, and many have adopted modern ideas and values. Although Pakistan has made rapid strides in industrialization, its economy still relies heavily on agriculture.

Pakistan's history dates back thousands of years. About 2500 B.C., a sophisticated civilization emerged in the Indus Valley, centered around the cities of Mohenjo-Daro and Harappa. Later, over the course of several thousand years, a variety of peoples—Afghans, Arabs, Greeks, Persians, and Turks—came to the region.

In the 1800's, the area that makes up Pakistan and India came under British colonial rule. In 1947, Pakistan was created as a homeland for Muslims, while India was primarily Hindu. The people of Kashmir were Muslim, but the region was ruled by a Hindu prince who tried to join his lands to India. Pakistan and India have struggled over control of the region ever since.

Pakistan initially consisted of two parts called East Pakistan and West Pakistan. More than 1,000 miles (1,600 kilometers) of Indian territory separated the two sections, but the people in both sections were Muslim. West Pakistan tended to dominate East Pakistan, which had a majority of the population. In 1971, East Pakistan won a nine-month civil war and became the independent nation of Bangladesh (see **Bangladesh**).

Government

In 1999, General Pervez Musharraf led a military coup that overthrew Pakistan's democratically elected government. He dissolved the parliament, suspended the Constitution, and declared himself head of a transitional government. Pakistan's Supreme Court ordered that civilian government be restored by October 2002, and

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Musharraf agreed. In 2001, Musharraf elevated himself to the presidency, and in 2002, he enacted sweeping changes to the Constitution that cemented his hold on power. Before the coup, Pakistan had a parliamentary system of government.

National government. Before the 1999 coup, an elected prime minister headed the Pakistani government, and the president served as the head of state. The Cabinet and the prime minister were members of a two-chambered parliament. The prime minister was the leader of the party with the most seats. In the upper house, called the Senate, the four provinces of Pakistan had equal representation. Provincial assemblies, elected by the voters, chose the members of the Senate. The people directly elected the members of the lower house, called the National Assembly.

Provincial and local government. Pakistan has four provinces—Baluchistan, North-West Frontier Province, the Punjab, and Sind. Before the military take-over, each province had an elected assembly. Elected and appointed officials govern cities, towns, and villages.

The federal government rules Pakistan's capital, Islamabad, as a separate district called the Capital Territory of Islamabad. Areas called Federally Administered Tribal Territories lie in northwestern Pakistan.

Politics. The Pakistan Muslim League (PML) and the Pakistan People's Party (PPP) are the two largest political parties in Pakistan. The PML's main support base is in the Punjab, while the PPP has a strong following in Sind as well as in parts of the Punjab and the North-West Frontier Province. Other parties include religious parties, such as the Muslim parties Jamaat-i-Islami and the Jamiat-i-Ulama-Islam. Beginning with local elections in 2000, the voting age was reduced from 21 to 18.

Courts. The Supreme Court is Pakistan's highest court. Its decisions are binding on all Pakistani courts, including the Federal Shariat Court, which oversees Islamic aspects of law. Each province has a High Court and other courts with civil and criminal jurisdiction.

Armed forces. An army of more than 500,000 and a smaller navy and air force are the main branches of the armed forces. Military service is voluntary, and the minimum age to volunteer is 17.



Karachi is Pakistan's largest city and commercial center. It is also the country's chief port and the capital of Sind Province. Karachi lies in southern Pakistan on the coast of the Arabian Sea.

People

Ancestry. Pakistan's people are descended from many different cultures. The earliest inhabitants in the region belonged to the same ethnic group as the people in northern India. Over the centuries, Afghans, Arabs, Greeks, Persians, and Turks came with invading armies. Many of the invaders settled in the area and intermarried with the inhabitants. These multiple influences added layers of variety to Pakistani culture.

Cultural groups and languages. Despite the bond of Islam, cultural differences divide the people of Pakistan. Each group has its own language and customs. Some Pakistanis feel greater loyalty to their own cultural group than to the nation.

Language is an important factor that distinguishes cultural groups. Major regional languages include Baluchi, Punjabi, Pashto (also called Pakhto), and Sindhi. Urdu is Pakistan's official language, but less than 10 percent of the people speak it as their primary language.

The Punjabis, the largest cultural group, speak different dialects of the Punjabi language. They live mainly in the Punjab but have a presence in other parts of the country, especially Karachi. Members of this group control the government, economy, and armed forces.

Urdu-speaking Muhajirs immigrated to Pakistan from India when the two countries separated in 1947. The Muhajirs became prominent in government after independence, but they have since lost power. Their descendants, most of whom live in Karachi or Hyderabad, blame Punjabi dominance for their declining influence.

Other leading groups include the Sindhis, the Pashtuns (also called Pakhtuns), and the Baluchi. The Sindhis have a slight majority in Sind but are outnumbered by Muhajirs and other non-Sindhi groups in major cities, such as Karachi. Muhajirs and Sindhis have clashed over educational and employment opportunities and political control of Karachi. The Pashtuns, who belong to various tribes and speak Pashto (or Pakhto), inhabit the North-West Frontier Province and the northern part of Baluchistan. Baluchis consist of several nomadic and tribal groups. They speak dialects of Baluchi and live in Baluchistan, the largest but least populated province of Pakistan. Baluchistan is also home to smaller cultural groups, such as the Brahuis, Makranis, and Lassis.

Millions of refugees from Afghanistan form another cultural group in Pakistan. They fled to Pakistan to escape decades of war in Afghanistan. They live mainly in the North-West Frontier Province and Baluchistan but also have a sizable presence in Karachi.

Way of life

Rural life. About two-thirds of Pakistanis live in rural areas. Most of them are farmers, herders, and skilled workers, such as carpenters and bricklayers. Local customs and beliefs play an important part in rural life.

Housing and clothing vary from one region to another, depending on climate, local customs, and economic conditions. Most rural villages consist of clusters of two- or three-room houses made of clay or sun-dried mud.

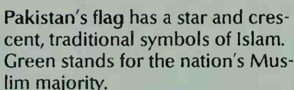
Pakistan in brief

General information

Capital: Islamabad.
Official name: The Islamic Republic of Pakistan.
Official language: Urdu.
Largest cities (1981 census):

Karachi (5,208,170)	Faisalabad (1,104,209)
Lahore (2,952,689)	Rawalpindi (794,843)





Pakistan's flag has a star and crescent, traditional symbols of Islam. Green stands for the nation's Muslim majority.



A wreath of narcissus, the national flower, encircles a shield on the Pakistani coat of arms.

Land and climate

Land: Pakistan lies in southern Asia, north of the Arabian Sea. It borders Iran, Afghanistan, China, and India. Mountains cover most of northern and western Pakistan. The Thar Desert covers much of southeastern Pakistan, and most of southwestern Pakistan is an arid plateau. A major river system waters the fertile plains of central Pakistan.
Area: 307,374 mi^2 (796,095 km^2). *Greatest distances*—north-south, 935 mi (1,505 km); east-west, 800 mi (1,287 km). *Coastline*—506 mi (814 km).
Elevation: *Highest*—K2 (in Kashmir), 28,250 ft (8,611 m) above sea level. *Lowest*—sea level.
Climate: Most of Pakistan has a dry climate, with hot summers and cool winters. Pakistan averages only about 10 inches (25 centimeters) of rain a year. But the amount of rainfall varies greatly from year to year. Long dry spells may be broken by severe rainstorms that cause rivers to overflow and flood the countryside.



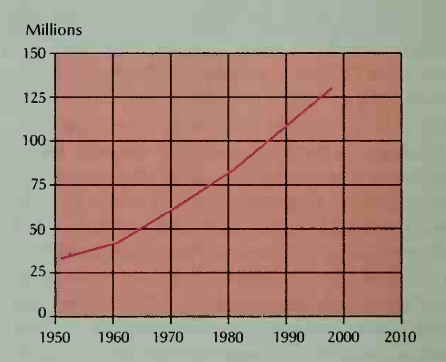
Government

Form of government: Federal republic.
Head of state: President.
Head of government: Prime minister.
Legislature: Parliament of two houses—the National Assembly and the Senate.
Executive: Prime minister and president each have some executive powers.
Judiciary: Highest court is the Supreme Court.
Political subdivisions: Four provinces and the Capital Territory of Islamabad.

People

Population: *Estimated 2002 population*—144,135,000; *1998 census*—130,579,571.
Population density: 469 per mi^2 (181 per km^2).
Distribution: 67 percent rural, 33 percent urban.
Major ethnic groups: Punjabi, Sindhi, Pashtun (or Pakhtun), Baluchi, and Muhajir.
Major religions: 77 percent Sunni Muslim, 20 percent Shiite Muslim, 3 percent other, including Christian and Hindu.

Population trend



Year	Population
1951	33,779,500
1961	42,880,000
1972	64,892,000
1981	84,253,000
1998	130,579,571

Economy

Chief products: *Agriculture*—wheat, cotton, rice, sugar cane, milk, chickpeas. *Manufacturing*—cotton textiles and clothing, food products, fertilizer, steel, cement. *Mining*—natural gas, petroleum.
Money: *Basic unit*—Pakistani rupee. One hundred paisas equal one rupee.
Foreign trade: *Major exports*—textiles, including garments, cotton cloth, and yarn; agricultural products; leather goods; and carpets. *Major imports*—petroleum goods, machinery, transportation equipment, and chemicals. *Major trading partners*—United States, United Kingdom, Japan, Germany, Saudi Arabia, United Arab Emirates.



Pakistan map index

Cities and towns

Abbottabad .....32,188 C 6
Ahmadpur
East ....56,979 E 6
Arifwala ....43,654 E 6
Bahawainagar ..74,533 E 6
Bahawalpur ...180,263 E 6
Bannu ....35,170 C 5
Bhakkar ....41,934 D 5
Bhera ....29,654 C 6
Chakwai ....43,670 C 6
Chaman ....29,793 D 3
Charsadda* .....62,530 B 6
Chichawatni* ....50,241 D 5
Chiniot ....105,559 D 6
Chishtian
Mandi ....61,959 E 6
Dadu ....39,298 F 4
Daska* ....55,555 D 7
Dera Ghazi
Khan ....102,007 E 5
Dera Ismail
Khan ....64,358 D 5
Faisalabad ...1,104,209 D 6
Gilgit ....B 7
Gojra ....68,000 D 6
Gujar Khan .....33,920 C 7
Gujranwala ....637,591 D 7
Gujrat ....155,058 C 7
Hafizabad ....83,464 D 7
Harunabad ......42,590 E 7
Hasilpor* ....37,026 E 6
Hyderabad ....751,529 G 4
Islamabad .....204,364 C 6
Jacobabad ......79,365 F 4
Jalapur ....29,590 C 7
Jaranwala* ......69,459 D 6
Jhang Sadar ...195,558 D 6
Jhelum ....92,646 C 7
Kahror Pakka ...35,600 E 6
Kamalia ....61,107 D 6
Kamoke* ....71,097 D 7
Karachi ......5,208,170 G 4
Kasur ....155,523 D 7
Khairpur ....61,447 F 5
Khanewal ....89,090 E 6
Khanpur ....70,589 E 5
Khushab ....56,274 C 6
Kohat ....55,832 C 6
Kot Addu ....37,479 D 5
Kotri ....39,390 G 4
Lahore ....2,952,689 D 7
Lala Musa ....46,626 C 7
Larkana ....123,890 F 4
Leiah ....51,482 D 5
Mailsi* ....33,652 E 6
Mandi
Bahauddin* ...44,796 C 7
Mandi
Burewala ......86,311 E 6
Mardan ....141,842 B 6
Mian Channun* .40,609 D 6
Mianwali ....59,159 C 6
Mingaora* ......88,078 B 6
Mirpur Khas ...124,371 G 5
Mitha Tiwana* ..28,959 C 6
Multan ....736,925 E 6
Muzaffarabad ....B 7
Muzaffargarh ...53,192 E 6
Nankana Sahib* .32,963 D 7
Narowal* ....35,125 C 7
Nawabshah ....102,139 G 4
Nowshera ....38,875 C 5
Okara ....127,455 D 7
Pakpattan ....69,820 D 7
Peshawar ......506,896 C 6
Quetta ....285,719 E 4
Rahimyar Khan 119,086 F 5
Rawalpindi ....794,843 C 6
Rohri ....31,332 F 5
Sadiqabad ......63,935 F 5
Sahiwal ....150,954 D 6
Sangia* ....33,771 D 7
Sargodha ......291,362 D 6
Shahdadkot .....32,888 F 4
Shahdadpur ....42,107 G 4
Shekhupura ...141,168 D 7
Shikarpur ....88,138 F 4
Shujaabad ......37,810 E 6
Sialkot ....302,009 C 7
Sukkur ....190,551 F 4
Swabi ....46,344 C 6
Tando Adam ....62,744 G 4
Tando Allahyar .30,647 G 4
Tando
Muhammad
Khan ....41,757 G 4
Toba Tek Singh .37,844 D 6
Turbat ....52,337 G 2
Vihari ....53,799 E 6
Wah ....122,335 C 6
Wazirabad* .....62,725 C 7
Zhob ....31,931 D 5

*Does not appear on map; key shows general location.
Source: 1981 census.

Most of these homes have little furniture. People sit and eat on earthen floors covered by straw or woven mats. Many homes lack basic plumbing and electric power.

City life. A majority of urban dwellers cannot read or write, or can read and write only a little. Most earn a living as unskilled laborers, factory workers, shopkeepers, or craftworkers. Many live in modest houses in old, crowded neighborhoods or in makeshift homes on empty plots of land. Sanitation is poor in the inner cities.

The middle and upper classes, who make up a small percentage of the population, reside in spacious homes in comfortable urban neighborhoods. Many of these people have been educated in English and know a great deal about Western styles and ideas. They stand in stark contrast to the majority of Pakistanis, who are rooted in their traditional cultures.

Clothing. Pakistanis wear different clothing depending on their region. The most common garment worn by both men and women is the *shalwar-qamiz* (or *salwar-kameez),* which consists of loose trousers and a long, knee-length shirt. Women also wear a *dupatta* (scarf) or a shawl called a *chador* or *chadar* over the shoulders and head. Outside the home, some women cover themselves with a tentlike garment called a *burqa* or *burka.* In parts of the Punjab, some men wear skirtlike garments called *dhotis* or *lungis.* Many Punjabi women prefer the loose, skirtlike *ghagra* instead of the shalwar-qamiz. Turbans and woolen or fur caps are popular head coverings among Pakistani men.

Food and drink. Wheat and other grains are the staple diet of most Pakistanis. They eat flat loaves of bread called *chapattis* or *nans* with cooked lentils, vegetables, and mutton, beef, or chicken curries. *Biryani* and *pilau* are rice dishes mixed with meat, vegetables, raisins, and nuts. Pakistanis like food flavored with spicy seasonings. They do not eat pork, which is forbidden by Islam. Desserts such as *kheer* (a kind of rice pudding) and *halwa* or *halva* (a confection made with ground seeds or dried fruits or vegetables) are popular. Fresh and dried fruits are also eaten as desserts. Tea with milk and sugar is a favorite drink. In hot weather, Pakistanis enjoy a yogurt beverage called *lassi,* flavored with sugar or salt.

Recreation. Sightseeing, picnics, eating out, fairs, motion pictures, and theater are popular recreational activities in Pakistan. In rural areas, wrestling, horse racing, and *tent pegging* (a horse riding game) are favorite sports. Satellite television and movies on videotape have become popular, especially in urban areas. Interest has grown in organized sports, such as cricket, field hockey, football, tennis, squash, and volleyball.

Religion. More than 97 percent of Pakistan's people practice Islam. The majority of Pakistan's Muslims belong to the Sunni division of Islam. Only about 20 percent belong to the Shiite division. The end of Ramadan, the month of fasting, and the *hajj,* the annual pilgrimage to Mecca, are important religious holidays. People of other religions in Pakistan include Christians, Hindus, Buddhists, and Parsis.

Education. A little over half the men and less than a third of the women above the age of 15 can read and write. School attendance is not compulsory, and less than half of the children of school age attend school. Pakistan suffers from a shortage of schools, qualified teachers, and instructional materials. However, wealthy Pakistanis have access to high-quality private schools.

Islamic religious schools called *madrasahs* have become popular in both rural and urban areas. These schools teach the Qur'ān and other beliefs of Islam. Some of the schools foster religious extremism, although the government has tried to stop this.

Pakistan has over 20 universities and several private colleges. Some of the largest educational institutions are the universities of Karachi, Peshawar, and the Punjab.

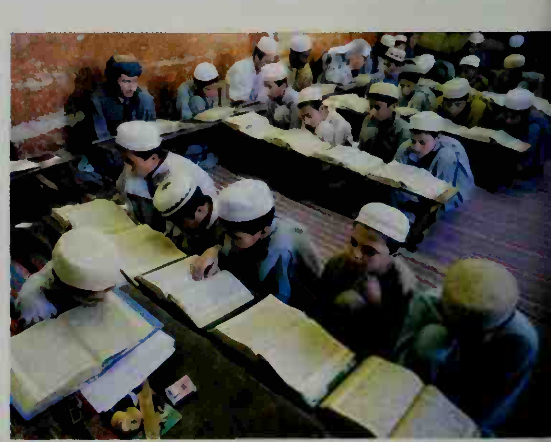
The arts. Each region of Pakistan has its own folk literature, consisting of stories and songs about legendary or historical personalities. Folk theater based on myths and legends is immensely popular in the rural areas. In the cities, motion pictures—either in theaters or on video—are in great demand. Art and architecture in Pakistan show the influence of both Islamic and local cultural traditions. Pakistanis have a passion for folk, classical, and popular music, and several Pakistani musicians have acquired an international following.

Land and climate

Pakistan has five main land regions: (1) the Northern and Western Highlands, (2) the Punjab Plain, (3) the Sind Plain, (4) the Baluchistan Plateau, and (5) the Thar Desert.

Mountains cover much of northern and western Pakistan, known as the Northern and Western Highlands. K2, the second highest peak in the world, towers 28,250 feet (8,611 meters) above sea level in the part of Kashmir controlled by Pakistan. Only Mount Everest is higher. Mountain passes cut through the rugged peaks at several points. The most famous of these passes, the Khyber Pass, links Pakistan and Afghanistan. The mountain regions have the coolest weather. Summer temperatures in the north and northwest average about 75 °F (24 °C), and winter temperatures often fall below freezing.

The Punjab Plain and the Sind Plain occupy most of the eastern part of the country. These regions are *alluvial plains* (land formed of soil deposited by rivers). In the north, the Punjab is watered by the Indus River and four of its tributaries—the Chenab, Jhelum, Ravi, and Sutlej rivers. The combined waters of these four tributaries join the Indus River in east-central Pakistan. South



© Paula Bronstein, Getty Images

Students at an Islamic religious school called a *madrasah* spend most of their time studying the Qur'ān, the sacred book of the Muslims, and other teachings of Islam. Many Pakistani children attend a madrasah instead of a public school.

of this meeting point, the broadened Indus flows to the Arabian Sea through the Sind Plain.

In the Punjab, temperatures average over 90 °F (32 °C) in summer and about 55 °F (13 °C) in winter. The eastern part of the Punjab receives the most rain—more than 20 inches (51 centimeters) a year. Extensive irrigation systems have made the Punjab and Sind plains fertile agricultural regions.

The Baluchistan Plateau lies in southwestern Pakistan. Most of the plateau is dry and rocky and has little plant life. Much of the Baluchistan Plateau receives less than 5 inches (13 centimeters) of rain a year.

The Thar Desert lies in southeastern Pakistan and northwestern India. Much of the desert is a sandy wasteland. However, irrigation projects have made parts of the desert near the Indus River suitable for farming.

Most of Pakistan has a dry climate, with hot summers and cool winters. Pakistan averages only about 10 inches (25 centimeters) of rain a year. But the amount of rainfall varies greatly from year to year. Long dry spells may be broken by severe rainstorms that cause rivers to overflow and flood the countryside. In general, most of the rain falls from July to September, when the summer *monsoon* (seasonal wind) blows across Pakistan.

Economy

Pakistan has a developing economy. About a third of its people live below the poverty line. Agriculture remains the leading economic activity, but service industries and manufacturing have grown in importance.



© Robin Laurance, Impact Photos

The Khyber Pass is the easiest land route between Pakistan and Afghanistan. The pass cuts through the Safed Koh mountains, which are part of the Hindu Kush range. This part of the Khyber Pass is near Peshawar, Pakistan.

Natural resources. Pakistan's rivers are its most valuable natural resource. They supply water to irrigate over 38 million acres (15 million hectares) of farmland and also provide an important source of hydroelectric power. Central Pakistan has extensive natural gas reserves.

Pakistan terrain map



Physical features

Arabian Sea ....F 1
Baluchistan Plateau .....E 2
Chagai Hills ....D 2
Chenab (River) ....C 5
Dasht (River) ....E 1
Hab (River) ....F 3
Himalaya (Mts.) ....B 6
Hindu Kush (Mts.) ....B 4
Hingol (River) ....E 2
Indus (River) ....E 3
Jhelum (River) ....C 5
Karakoram Range ....A 5
Khyber Pass ....B 4
Kirthar Range ....E 3
K2 (Mtn.) ....A 6
Makran Coast Range ......E 2
Mangla Dam ....C 5
Mintaka Pass ....A 5
Nanga Parbat (Mtn.) .....B 5
Nara Canal ....E 4
Northern and Western Highlands ...C 4
Punjab Plain ....C 5
Ras Koh Range ....D 3
Ravi (River) ....C 5
Sind Plain ....E 3
Sulaiman Range ....D 4
Sutlej (River) ....D 5
Tarbela Dam ....B 5
Thal Desert ....D 4
Thar Desert ....E 5
Tirich Mir (Mtn.) ....A 4
Toba Kakar Range ....C 3
Zhob (River) ....C 4

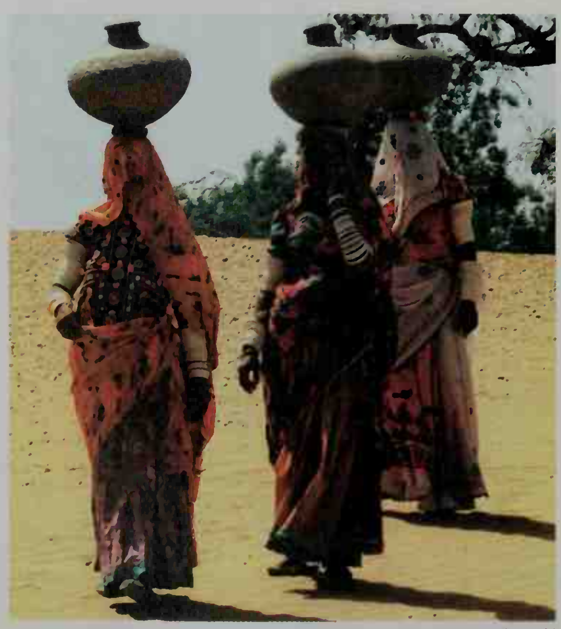
WORLD BOOK map

Agriculture employs about 40 percent of Pakistan's labor force and accounts for about 25 percent of its gross domestic product (GDP), the total amount of goods and services produced in the country. In the 1950's and again in the 1970's, Pakistan's government introduced land reforms to distribute land to the poor. It also tried to modernize agriculture by encouraging farmers to use fertilizers, pesticides, and new types of seeds. These efforts met with mixed success.

Wheat is the chief crop in Pakistan. Pakistani farmers also grow cotton, rice, sugar cane, chickpeas, oilseeds, fruits, and vegetables. Although mechanized agriculture has made some inroads, most farmers rely on cattle and water buffaloes to till the land. These animals also provide meat, milk, and hides. Many Pakistani farmers, especially in Baluchistan and the North-West Frontier Province, tend sheep and goats. Some parts of the country have poultry farms. Pakistan exports shrimps, sardines, sharks, and other fish caught in the Arabian Sea.

Service industries employ over 30 percent of Pakistan's work force and contribute about half of its GDP. The service sector has expanded considerably and is especially important in the major cities. Wholesale and retail trade are the largest employers in this sector. Finance, information technology, government, and transportation are other significant service industries.

Manufacturing employs about 18 percent of Pakistan's labor force and contributes about 20 percent of its GDP. Cotton textiles and clothing are the leading manufactured products. Other significant industries include food products, such as flour and sugar; fertilizer and other chemical products; steel; and cement. Craftworkers, operating from home or in small factories, make carpets, embroidered goods, pottery, wooden and leather products, and other handicraft items.



AP/Wide World

Women search for water in the Thar Desert, which lies along Pakistan's southeastern border with India. Much of the Thar is a wasteland, but irrigation has enabled some parts to be farmed.

Energy sources and mining. Fossil fuels, especially coal and petroleum, provide for over two-thirds of Pakistan's energy needs. Hydroelectric power provides the rest. The country imports oil but has rich deposits of natural gas. Salt, coal, chromite, gypsum, iron ore, and limestone are among Pakistan's other mined resources.

International trade. Pakistan's primary exports are textiles, including garments, cotton cloth, and yarn; agricultural products; leather goods; and carpets. Its main imports are petroleum goods, machinery, transportation equipment, and chemicals. Pakistan's chief trading partners are the United States, the United Kingdom, Japan, Germany, Saudi Arabia, and the United Arab Emirates.

Transportation and communication. Railways serve as the principal mode of transportation for passengers and freight in Pakistan. Paved roads link major towns and cities, but motor vehicle travel is limited. In rural areas, camels, cattle, donkeys, and horses provide transportation. Karachi is Pakistan's main seaport. Karachi, Lahore, and Islamabad have international airports.

Pakistan has far more radios than televisions, so radio remains the dominant mode of mass communication. Pakistan has a vibrant newspaper industry. Its publishers produce hundreds of daily newspapers and magazines in Urdu, English, and the regional languages.

History

Early civilizations. Pakistan has a long and complex history, dating back at least 8,000 years to the Mehrgarh civilization in present-day Baluchistan. Later, around 2500 B.C., one of the world's first great civilizations developed in the Indus Valley in what are now Pakistan and northwestern India. Ruins of Harappa and Mohenjo-Daro (also spelled Moenjodaro), the two major cities of the civilization, lie in present-day Pakistan. The ruins show that both cities were large and well-planned. By about 1700 B.C., the Indus Valley civilization had gradually declined. Scholars do not know why it collapsed.

Invasions and conquests. During the next several thousand years, many peoples from southwest and central Asia came into the region that is now Pakistan. About 1500 B.C., a central Asian people called Aryans came through the mountain passes to the Punjab region. In time, they settled across most of India. The Persians conquered the Punjab during the 500's B.C. and made it part of the huge Achaemenid Empire.

In 326 B.C., Alexander the Great of Macedonia took control of most of what is now Pakistan. A few years later, the emperor Chandragupta Maurya made the region part of the Mauryan Empire. The Mauryan Empire began to break up about 230 B.C. Greeks from the independent state of Bactria in central Asia then invaded the Indus Valley. They established a kingdom with capitals near the present-day cities of Peshawar and Rawalpindi.

About 100 B.C., Scythians from Afghanistan came into Baluchistan and Sind. In time, they conquered the Indus region. The Scythians were replaced by the Parthians, who, in turn, were conquered by the Kushans of central Asia. The Kushans ruled what are now Afghanistan, Pakistan, and northwestern India from about A.D. 50 to the mid-200's. They controlled the trade routes from China to India and the Middle East. Peshawar, the Kushan capital, became a commercial center.

During the mid-300's, the Indus Valley became part of

the Gupta Empire, which had expanded westward from northeastern India. Huns from central Asia overran Pakistan during the late 400's.

The Islamic impact. Around A.D. 712, Arab Muslims sailed across the Arabian Sea and invaded Sind, bringing Islam to the region. Beginning about 1000, Muslims invaded northern Pakistan from Iran. Mahmud Ghazni, an Afghan warrior of Turkish descent, established a Muslim kingdom that in time included the entire Indus Valley. Lahore became the capital of the kingdom and developed into a major center of Islamic culture.

In 1206, most of present-day Pakistan came under the control of the Delhi Sultanate, a Muslim empire based in northern India. Under the Delhi Sultanate, a distinctive Indo-Islamic culture developed. The sultanate lasted until 1526, when Babur, a Muslim ruler of Turkish and Mongol descent, invaded India from Afghanistan and founded the Mughal Empire.

The Mughal Empire in time encompassed virtually all of what are now Pakistan, India, and Bangladesh. Under Mughal rule, the Indo-Islamic culture reached its most sophisticated level. It gave rise to a new language, Urdu, which was influenced by both Hindi and Persian. A new religion called Sikhism, which drew upon elements in both Hinduism and Islam, came into being.

In the 1700's, regional rulers acquired greater power at the cost of the central Mughal government. Several groups, including Persians and Afghans, gained control of the region that is now Pakistan. Sikh kingdoms gained strength in the Punjab during the early 1800's, while Sind was ruled by independent Muslim kingdoms.

Colonialism. In the 1500's, European traders began competing for control of the profitable trade between Europe and southern Asia. In the 1600's, after seeking permission from the Mughal emperors, a number of trading companies established settlements along the coastal regions of India. By the mid-1700's, the British East India Company had emerged as the strongest trading power in India. As the Mughal Empire began to break up, the company gradually gained political control over much of India. It fought a series of wars in the Punjab and Sind during the late 1830's and 1840's and added these territories to its holdings.

Resentment of British rule led to many small rebellions and, in 1857, to a widespread uprising. After assisting the British East India Company in crushing the 1857 rebellion, the United Kingdom took control of the company and its territories. Princes controlled the rest of India, and the British made treaty arrangements with these rulers. By 1900, the United Kingdom directly or indirectly controlled all of what is now Pakistan. The territories directly ruled by the United Kingdom were known as British India. See **India** (History [map: British India]).

The British introduced a number of reforms, including a Western system of education. Many Hindus enrolled in the British schools as a way to advance in the colonial system. Some middle- and upper-class Muslims also enrolled, but the majority of Muslims continued to attend their own schools, which stressed religious education. As a result, large numbers of Hindus gained positions in business and government, but the majority of Muslims remained farmers and laborers.

The nationalist movement. The Indian National Congress was formed in 1885 to promote independence for British India. Hindus dominated the organization, and Muslim leaders disagreed on whether or not to cooperate with it. In 1906, some Muslims formed a separate political organization called the All-India Muslim League. The Congress and the Muslim League both sought greater self-government. But differences emerged over how to divide power fairly between Hindus and Muslims. The Muslims feared that Hindus would dominate an independent India.

In 1940, the Muslim League demanded independent Muslim states in northwestern and northeastern India. The president of the Muslim League, Mohammad Ali Jinnah, became the plan's principal supporter. The name *Pakistan,* which means *land of the pure* in Urdu, came to be used for Jinnah's proposed Muslim homelands.

Both the British government and the Indian National Congress rejected the League's demands. To show its strength, the Muslim League declared Aug. 16, 1946, as Direct Action Day. Muslims held nationwide demonstrations calling for the establishment of Pakistan. Violence broke out between Muslims and Hindus. In 1947, hoping to end the violence, the United Kingdom and Hindu leaders agreed to *partition* India—that is, to divide it into separate Hindu and Muslim countries.

Independence. Pakistan became an independent nation on Aug. 14, 1947. The next day, India gained independence. West Pakistan and East Pakistan were carved out of the northwestern and northeastern parts of India, separated by more than 1,000 miles of Indian territory. See **India** (History [map: Independent India]). Jinnah became the first head of state.

Violence between Hindus, Muslims, and Sikhs continued after the partition. Over 10 million people crossed the new borders. Hindus and Sikhs fled to India, and Muslims streamed into Pakistan. Religious riots killed at least half a million people.

Within months of partition, India and Pakistan went to war over Kashmir. A Hindu prince ruled this region, but most of its population was Muslim. When India and Pakistan were partitioned, the prince tried to avoid joining either country. Armed Pakistani tribesmen, backed by government troops, invaded Kashmir to claim it for Pakistan. In response, the prince joined Kashmir to India. Indian and Pakistani troops continued to fight until early 1949, when the United Nations negotiated a cease-fire.

Pakistan became a republic in 1956, but parliamentary elections did not take place as planned. Instead, the military under General Mohammad Ayub Khan assumed control of the state in 1958. Military leaders continued to control the government throughout the 1960's. In 1965, India and Pakistan fought a second war over Kashmir.

Civil war. The people of West and East Pakistan were divided as much by cultural differences as by geography. Only religion united the two groups. West Pakistan controlled the government, economy, and armed forces, which angered East Pakistanis. Bengali-speakers in East Pakistan also resented the government's efforts to impose Urdu as the official language.

In 1970, Pakistan held elections for a National Assembly that would draft a new constitution. East Pakistan had over half of the country's population, so a majority of the Assembly members represented East Pakistan. They hoped to frame a constitution that would give East Pakistan its due share of political and economic power.

In early 1971, Ayub Khan's successor, General Agha Mohammad Yahya Khan, postponed the first meeting of the National Assembly. Infuriated, East Pakistanis took to the streets, prompting a military crackdown. The riots grew into civil war. On March 26, 1971, East Pakistan declared its independence, calling itself Bangladesh. In December 1971, India sent its army to support the rebellion. The war developed into a major conflict with India, and the fighting spread to West Pakistan and Kashmir. On Dec. 16, 1971, Pakistan surrendered. Over a million people died in the fighting.

Yahya Khan resigned, and Zulfikar Ali Bhutto, whose Pakistan People's Party (PPP) held the largest number of seats in West Pakistan, took over as president. He swiftly restored constitutional government and civilian rule.

Struggle for democracy. In 1973, Pakistan adopted its third constitution, which provided for a two-chamber legislature, a president as head of state, and a prime minister as head of government. Bhutto became prime minister and concentrated power in his own hands. In 1977, he called elections in the face of mounting protest against his rule. Bhutto's PPP won the elections, but opponents accused the party of election fraud. Street demonstrations against the government erupted.

In July, General Mohammad Zia-ul-Haq ousted Bhutto from office and declared martial law. Zia assumed the presidency in 1978 while remaining chief martial law administrator. Zia's regime convicted Bhutto of ordering the murder of a political opponent, sentenced him to death, and executed him in 1979.

When the Soviet Union invaded Afghanistan in December 1979, Pakistan's military supported Afghanistan's Islamic resistance fighters. Zia postponed new elections indefinitely and initiated a series of *Islamization* policies, including a system of law enforcement and punishment based on Islamic principles. Many Islamization measures discriminated against women and minorities.

In 1985, Zia allowed new elections to national and provincial assemblies and lifted martial law. However, he also introduced an amendment to the Constitution that gave the president broad powers, including the power to dismiss elected governments and to dissolve parliament. Zia used these powers in 1988 to dismiss the prime minister and dissolve parliament. In August of that year, Zia died in a plane crash.



© Hulton Archive/Getty Images

Muslims board trains to Pakistan after the 1947 *partition* (division) of India along religious lines. Millions of Muslims moved to Pakistan, and millions of Hindus and Sikhs moved to India.

After the Soviets withdrew from Afghanistan in 1989, Pakistan's military continued to support Islamic extremist groups in Afghanistan. Chief among these groups were the Taliban, many of whom were educated in religious schools in the North-West Frontier Province. By the late 1990's, the Taliban controlled most of Afghanistan.

From 1988 to 1999, two parties governed Pakistan alternately—the PPP, led by Benazir Bhutto, the daughter of Zulfikar Ali Bhutto; and the Pakistan Muslim League, led by Mohammad Nawaz Sharif. From 1985 to 1996, three presidents used Zia's constitutional amendment to dismiss four elected governments and parliaments. After the Muslim League won elections in 1997 with a two-thirds majority, Pakistan's legislature repealed the amendment. This reduced the powers of the presidency and made the office of prime minister, then held by Sharif, Pakistan's most powerful government post.

Recent developments. In May 1998, India carried out a series of nuclear tests and declared itself capable of producing and using nuclear weapons. Pakistan responded by conducting its own nuclear tests.

In May 1999, conflict broke out again in Kashmir. Militants backed by Pakistani troops crossed the Kashmiri cease-fire line into Indian-held territory. Fighting then broke out between the militants and Indian troops. In July, under pressure from the United States and other countries, Prime Minister Sharif called for the withdrawal of the Pakistani militants.

In 1999, General Pervez Musharraf led a military coup that overthrew Sharif's government. Musharraf dissolved the parliament and suspended the Constitution. He declared himself the head of a transitional government that included a cabinet and a National Security Council, made up of several Cabinet ministers and the chiefs of staff of the army, navy, and air force. Pakistan's Supreme Court ordered that civilian government be restored by October 2002, and Musharraf agreed to follow the order. Sharif was later exiled to Saudi Arabia. In 2001, Musharraf declared himself president.

Following the September 11 terrorist attacks on the United States, Musharraf allowed U.S. forces to use Pakistani military bases and fly over Pakistani territory in a military campaign against terrorists in Afghanistan. Pakistani supporters of Afghanistan's Taliban government protested against the U.S. attacks and against Musharraf for his support of the United States.

In 2001, armed terrorists attacked India's Parliament, killing or injuring over 20 people, though no elected officials were hurt. India blamed Pakistan for the attack, but Pakistan denied that it had supported the terrorists. The incident led both countries to build up military forces along their shared border. In May 2002, militants in the disputed region of Kashmir attacked Indian outposts there. Troops on both sides exchanged artillery fire, and the two countries seemed on the brink of war.

At Musharraf's request, a referendum was held in April 2002 to extend his term as president for five years.

In August 2002, Musharraf enacted sweeping constitutional changes that cemented his hold on power. Parliamentary elections were scheduled for October 2002.

Ayesha Jalal

Related articles in *World Book* include:

Cities

Islamabad
Karachi
Lahore

History

Bhutto, Benazir
Colombo Plan
Iqbal, Sir Muhammad
Jinnah, Mohammad Ali

Physical features

Arabian Sea
Hindu Kush
Hunza
Indus River
Khyber Pass
Thar Desert

Other related articles

Kashmir
Muslims
Punjab
Sikhism
Taliban
Tarbela Dam

Outline

I. Government
A. National government
B. Provincial and local government
C. Politics
D. Courts
E. Armed forces

II. People
A. Ancestry
B. Cultural groups and languages

III. Way of life
A. Rural life
B. City life
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D. Food and drink
E. Recreation
F. Religion
G. Education
H. The arts

IV. Land and climate

V. Economy
A. Natural resources
B. Agriculture
C. Service industries
D. Manufacturing
E. Energy sources and mining
F. International trade
G. Transportation and communication

VI. History

Questions

In what region of Pakistan do most of the country's people live?
Who was Mohammad Ali Jinnah?
What desserts are popular in Pakistan?
What are Pakistan's leading manufactured products?
Why is Kashmir disputed between India and Pakistan?
What is a *shalwar-qamiz?* A *chador?*
Which city is Pakistan's main seaport?
What is the largest cultural group of Pakistan?
What has made the Punjab and Sind plains fertile regions?
Why did Muslims want their own homeland when plans for an independent India were formed?

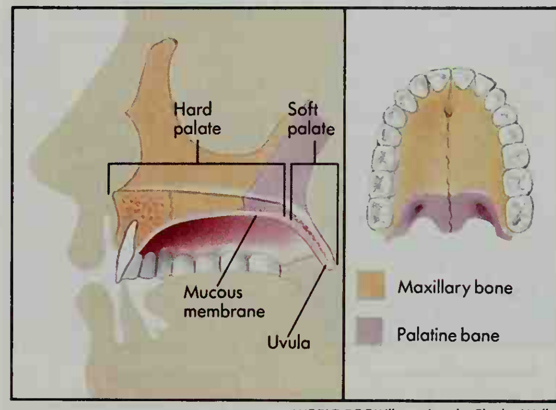
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Palace usually refers to the official residence of a king, queen, emperor, or empress. Most palaces are large, ornate structures. *World Book* has many articles and pictures of famous palaces. See the following articles:

Aegean civilization
Alhambra
Buckingham Palace
Escorial
Fontainebleau
Knossos
Kremlin
Saint Petersburg
Tuileries
Versailles, Palace of
Windsor Castle

Palate, *PAL iht,* is the roof of the mouth. The palate has two parts, the *hard palate,* in front, and the *soft palate,* behind. The hard palate is composed of the *palatine* bones and parts of the *maxillary* bones. It is covered with a *mucous membrane.* The soft palate is a fold of muscular tissue covered by epithelial tissue with mucous glands. The palate separates the mouth and the nasal cavity. During swallowing, the soft palate rises and blocks off the rear nasal passage. A projection called the *uvula* hangs from the middle of the soft palate.



WORLD BOOK illustrations by Charles Wellek

The palate, or roof of the mouth, separates the mouth and nasal cavities. It has two parts, *left:* (1) the bony *hard palate* in front, and (2) the muscular *soft palate* in the rear. Both parts are covered by a mucous membrane. The hard palate is formed by parts of the maxillary and palatine bones, *right.*

Only mammals and crocodiles have a palate like that of a human being. In other animals, the base of the skull also serves as the roof of the mouth. Fishes, amphibians, and reptiles may have teeth on the palate. In amphibians, the palate aids in breathing.

Raymond L. Burich

See also **Cleft palate; Mouth.**

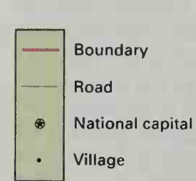
Palatinate, *puh LAT uh NAYT,* was the name of two little countries of the old German Empire. The two Palatinates were one political unit until 1620. One was called the Upper Palatinate. The other was called the Lower, or Rhenish, Palatinate. The name *Palatinate* once referred to a castle of the German emperor. The Upper Palatinate is now part of Bavaria. The Lower Palatinate is part of Rhineland-Palatinate. The Lower Palatinate region has fertile soil. It produces good crops of potatoes, tobacco, hemp, flax, wheat, rye, and barley. It has always been noted for its wine. See also **Bavaria.**

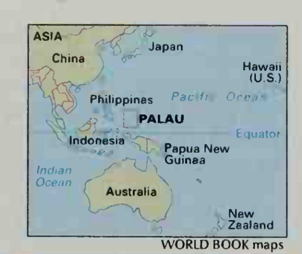
Phillip N. Bebb

Palau is a small island nation in the western Pacific Ocean. The country is also known as Belau. Palau consists chiefly of about 200 islands in a chain that lies about 500 miles (800 kilometers) east of the Philippines. Palau is part of the Caroline Islands, which belong to a larger island group known as Micronesia.

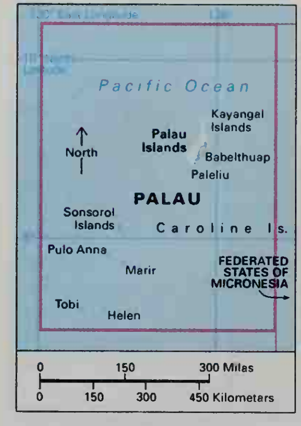
The United States administered the Palau islands under a United Nations trusteeship called the Trust Territory of the Pacific Islands from 1947 until 1994. That year, Palau became independent. About 20,000 people live in Palau. Koror, on Koror Island, is the capital.

Palau





WORLD BOOK maps





Government. Palau is a republic in *free association* with the United States. Under this arrangement, the Palauan government controls the nation's internal and foreign affairs. However, the United States is responsible for the defense of the islands.

Palau's government is divided into executive, legislative, and judicial branches. The president is elected to a four-year term. Palau has a two-house legislature. Voters elect its 14 senators and 16 delegates every four years. Judges are appointed for life by the president with the consent of the Senate.

People. Most Palauans are descended from the people who originally settled the islands thousands of years ago. About two-thirds of Palau's people live on Koror Island. Most of them work for government agencies. Most of the rest of the islands' people live in scattered rural villages. They farm the land but grow barely enough food to make a small profit. The main foods of Palauans include seafood and *taro,* a plant with a starchy, edible underground stem.

Palauan and English are both official languages of Palau. Palauan children from ages 6 to 14 must attend school. About three-quarters of the people of Palau are Christians. The other one-fourth of the population follow a local religion known as *Modekngei,* which emphasizes traditional Palauan culture and values.

Land and climate. Palau consists mainly of a chain of about 200 islands. The chain extends approximately 100 miles (160 kilometers) from north to south and is about 20 miles (32 kilometers) wide. It is surrounded by a coral reef and is often referred to as the Palau Islands. However, several other scattered islands are also part of Palau. Altogether, Palau has a land area of 177 square miles (459 square kilometers). Babelthuap, also spelled Babeldaob, is Palau's largest island.

The northern islands of Palau are of volcanic origin and have rich soils. Most of these islands are fertile and have many trees. The southern islands are upraised coral formations. Most of these islands are too rugged for people to live on. But they are a major tourist attraction because of their spectacular natural beauty.

Palau has a tropical climate, with daytime temperatures of about 80 °F (27 °C). The islands receive more than 150 inches (380 centimeters) of rain a year.

Economy. The Palauan government provides most jobs and a wide range of social services for the Palauan people. Most of the money for the government operations comes from the United States.

Palau imports finished consumer goods and much of its food. Its chief export is tuna, which is shipped mainly to Japan. Coconut is the chief cash crop. Tourism is becoming an important industry.

History. Archaeological evidence suggests that Palau was one of the first island groups in Micronesia to be settled. The ancestors of the islanders may have arrived from Southeast Asia at least 4,000 years ago.

Spain ruled Palau from 1885 to 1898, when Germany gained control. After Germany's defeat in World War I (1914-1918), Japan administered the islands. Palau became Japan's headquarters for Micronesia, and the islanders were soon outnumbered by Japanese settlers.

After World War II ended in 1945, the Japanese settlers were sent back to Japan. In 1947, the United States began administering the islands as part of the Trust Territory of the Pacific Islands. Palau became a self-governing republic in free association with the United States in October 1994. In December 1994, it became a member of the United Nations. Robert C. Kiste

See also **Caroline Islands.**

Paleobotany, *PAY lee oh BAHT uh nee,* is the study of ancient plants. Paleobotany is a branch of *paleontology,* the study of ancient plants, animals, and other organisms. Specialists called *paleobotanists* investigate the evolution of plant life and the origins and relationships of plant groups. They also examine the link between vegetation and the earth's changing climate. Paleobotany includes the study of such simple organisms as ancient algae, fungi, and bacteria. In addition, it involves searching for the earliest evidence of life in rocks more than 3 billion years old.

Paleobotanists interpret the earth's history by examining plant fossils. These fossils have been preserved in *sedimentary rocks* (rocks formed from deposits laid down by ancient rivers, lakes, and seas). Paleobotanists have found the earliest land plants in sedimentary rocks that are more than 430 million years old. Remains of early forests are abundant in rocks 350 million years old. The ancestors of all major groups of land plants lived in these forests. Today, the most numerous plants on earth are *angiosperms* (flowering plants). Paleobotanists have discovered that the first angiosperms appeared about 140 million years ago, during the age of the dinosaurs.

Paleobotanists study the features that plants have developed to survive in their environment. These scientists are thus able to describe the type of climate that existed millions of years ago. Paleobotany contributes to an understanding of how and why the earth's climate changes. This understanding is important in predicting the changes in climate that humans may cause through the *greenhouse effect* (a gradual warming of the earth's surface). James F. Basinger

Paleogeography. See Paleontology.

Paleography, *PAY lee AHG ruh fee,* is the study of ancient and medieval handwriting. It deals mainly with writing on perishable materials, such as papyrus, parchment, or paper. A related field called *epigraphy* is the study of writing cut in more permanent material, such as metal or stone.

Specialists called *paleographers* study and translate ancient and medieval writings. They carefully examine the shape of the letters and the abbreviations used. They classify various writing styles and trace their historical development. With these techniques, paleographers can identify where and when unsigned and undated manuscripts probably were written.

Medieval styles of handwriting included *book hands,* also called *formal hands; documentary hands,* also called *diplomatic* or *informal hands;* and *national hands.* Book hands were made up of capital and small letters. Documentary hands consisted of flowing writing with the letters joined together. National hands differed according to geographical areas. A style called *Gothic script* or *black letter,* which had heavy lines, became widely used in Europe between the 1100's and the 1500's. *Humanistic script* was popular in Europe in the 1500's and the 1600's. It consisted of two styles that resembled Roman and italic type. These words are set in Roman type, and *these words are in italic type.*

Paleographers study writing that dates up to the 1600's. By that time, printed works had replaced most handwritten manuscripts. Jean Mabillon, a French monk, wrote what was probably the first book on paleography, *De re diplomatica,* in 1681. Julian G. Plante

Paleolithic Period. See Stone Age.

Paleontology, *PAY lee ahn TAHL uh jee,* is the study of animals, plants, and other organisms that lived in prehistoric times (more than 5,500 years ago). Fossil remains of organisms occur in layers of *sedimentary rocks* (rocks formed when mineral matter settled out of air, ice, or water). The organisms that are now fossils were alive when the rocks were being formed. They were buried and preserved as the layers of rock piled up.

By studying fossils, paleontologists learn what kind of life existed in various periods of the earth's history. The oldest known fossils are bacteria that lived about $3\frac{1}{2}$ billion years ago. The fossil record shows a gradual increase in the complexity of animals and plants. This gradual change in body form is called *evolution.*

Paleontology is important in the study of geology. The age of rocks may be determined by the fossils in them. Fossils also tell whether rocks were formed under the ocean or on land. Most rocks that contain marine shell fossils were formed under the ocean. Most rocks that contain land animal and land plant fossils were formed on land. The knowledge of where rocks were formed helps scientists map the world as it was millions of years ago. Such scientists are called *paleogeographers.*

Paleontology aids in the location of oil. Oil is often found in rocks that contain certain fossils. Oil companies use such fossils as a clue to where to find oil.

There are three main branches of paleontology: (1) invertebrate paleontology, (2) vertebrate paleontology, and (3) paleobotany. Invertebrate paleontology deals with fossil *invertebrates* (animals without backbones), such as mollusks and corals. Vertebrate paleontology is concerned with extinct fishes, amphibians, reptiles, birds, and mammals. Paleobotany is the study of fossil plants. Michael R. Voorhies

See also **Broom, Robert; Fossil; Osborn, Henry Fairfield; Teilhard de Chardin, Pierre.**

Paleozoic Era. See **Earth** (The Paleozoic Era).

Palermo, *puh LUR moh* or *puh LAIR moh* (pop. 698,556), is the capital and chief seaport of Sicily, an Italian island. It lies along the Tyrrhenian Sea in northwestern Sicily (see **Italy** [political map]). Palermo is a center of industry and trade. Produce from nearby farms is sold or processed there. Palermo exports agricultural products, including canned foods, citrus fruits, and wines. Industries include fishing and the manufacture of furniture, glass, steel, and textiles. People visit Palermo to see its museum, churches, and palaces. The city is the home of the University of Palermo. Modern suburbs surround the city's older section.

The Phoenicians founded Palermo between the 600's and 500's B.C. Muslims captured the city in A.D. 831. Under their rule, Palermo became a center of trade and culture. The Normans conquered the city in 1072 and made it the capital of the kingdom of Sicily. Several countries held Palermo before it became part of Italy in 1860. David I. Kertzer

Palestine, *PAL uh STYN,* a small, historic land at the eastern end of the Mediterranean Sea, is one of the world's most historic places. Two great religions—Judaism and Christianity—originated in Palestine. It is the Holy Land, the site of many events described in the Bible. Muslims, the followers of the Islamic religion, also consider Palestine a sacred place.

The Land of Canaan about 1000 B.C.

Most of the Land of Canaan, later called Palestine, was held by the Twelve Tribes of Israel. The names of these tribes are listed below, and their areas are shown by number on the map.

WORLD BOOK map



Palestine's location between Egypt and southwest Asia has made it a center of conflict for thousands of years. Many peoples have invaded the region, and there has never been an independent state of Palestine. In the 400 years before World War I (1914-1918), Palestine was part of the Ottoman Empire. After the war, Palestine came under British control. Both the Arab and Jewish inhabitants of Palestine fought for control of the territory. Following a war in 1948 and 1949 between Arabs and Jews, Palestine was divided among Israel, Jordan, and Egypt. Many of Palestine's residents became refugees. Conflicts over Palestine continued between Arabs and Jews after the war. For details, see *The continuing conflict and peace efforts* section of this article.

Early history and settlement. Amorites, Canaanites, and other Semitic peoples entered the area about 2000 B.C. The area became known as the Land of Canaan. Sometime between about 1800 and 1500 B.C., a Semitic people called Hebrews left Mesopotamia and settled in Canaan, where they became known as Israelites. Some of these Israelites later went to Egypt. In the 1200's B.C., Moses led the Israelites out of Egypt, and they returned to Canaan. The Israelites practiced a religion centered on the belief in one God. Other peoples in Canaan worshiped many gods.

For about 200 years, the Israelites fought the other peoples of Canaan and the neighboring areas. One of their strongest enemies, the Philistines, controlled the southwestern coast of Canaan—called Philistia.

Until about 1029 B.C., the Israelites were loosely organized into 12 tribes. The constant warfare with neighboring peoples led the Israelites to choose a king, Saul, as their leader. Saul's successor, David, unified the nation to form the Kingdom of Israel, about 1000 B.C. David established his capital in Jerusalem. His son, Solomon, succeeded him as king and built the first Temple for the worship of God. Israel remained united until Solomon's death about 928 B.C. The northern tribes of Israel then split away from the tribes in the south. The northern state continued to be called Israel. The southern state, called Judah, kept Jerusalem as its capital. The word *Jew,* which came to be used for all Israelites, comes from the name *Judah.*

Invasions and conquests. During the 700's B.C., the Assyrians, a people who lived in what is now Iraq, extended their rule westward to the Mediterranean Sea. They conquered Israel in 722 or 721 B.C. After about 100 years, the Babylonians began to take over the Assyrian Empire. They conquered Judah in 587 or 586 B.C. and destroyed Solomon's Temple in Jerusalem. They enslaved many Jews and forced them to live in exile in Babylonia. About 50 years later, the Persian king Cyrus conquered Babylonia. Cyrus allowed a group of Jews from Babylonia to rebuild and settle in Jerusalem.

The Persians ruled most of the Middle East, including Palestine, from about 530 to 331 B.C. Alexander the Great then conquered the Persian Empire. After Alexander's death in 323 B.C., his generals divided his empire. One of these generals, Seleucus, founded a *dynasty* (series of rulers) that gained control of much of Palestine about 200 B.C. At first, the new rulers, called Seleucids, allowed the practice of Judaism. But later, one of the kings, Antiochus IV, tried to prohibit it. In 167 B.C., the Jews revolted under the leadership of the Maccabeans and drove the Seleucids out of Palestine. The Jews reestablished an independent kingdom called Judah.

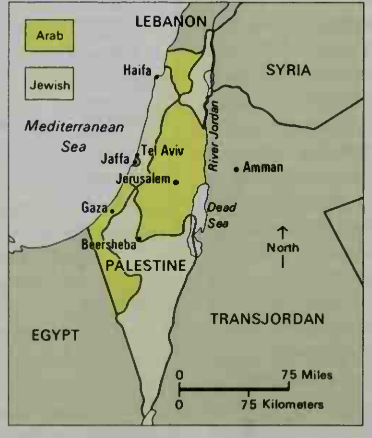
Roman rule. In 63 B.C., Roman troops invaded Judah, and it came under Roman control. The Romans called the area Judea. Jesus Christ was born in Bethlehem in the early years of Roman rule. Roman rulers put down Jewish revolts in A.D. 66 and A.D. 132. In A.D. 135, the Romans drove the Jews out of Jerusalem. The Romans named the area Palaestina, for Philistia, at about this time. The name *Palaestina* became *Palestine* in English.

Most of the Jews fled from Palestine. But Jewish communities continued to exist in Galilee, the northernmost

Palestine These maps show important stages in Palestine since World War I (1914-1918). In 1920, Palestine—previously part of the Ottoman Empire—became a mandated territory of the United Kingdom. The establishment of Israel in 1948 increased the conflicts between Arabs and Jews in the area.



The British mandate of Palestine is shown here as it existed in 1922. From 1920 to 1922, the mandate also included the Transjordan mandate to the east.



The United Nations partition plan of 1947 divided Palestine into Arab and Jewish areas. The Jewish area became the independent nation of Israel in 1948.



WORLD BOOK maps

Palestine today consists of the nation of Israel and the Arab areas of the Gaza Strip and the West Bank. Israel partially occupies the Arab areas.

part of Palestine. Palestine was governed by the Roman Empire until the A.D. 300's and then by the Byzantine Empire. In time, Christianity spread to most of Palestine.

Arab control. During the A.D. 600's, Muslim Arab armies moved north from Arabia to conquer most of the Middle East, including Palestine. Muslim powers controlled the region until the early 1900's. The rulers allowed Christians and Jews to keep their religions. However, most of the local population gradually accepted Islam and the Arab-Islamic culture of their rulers.

In the 1000's, the Seljuks, a Turkish people, began to take over Palestine. They gained control of Jerusalem in 1071. Seljuk rule of Palestine lasted less than 30 years. Christian crusaders from Europe wanted to regain the land where their religion began. The Crusades started in 1096. The Christians captured Jerusalem in 1099. They held the city until 1187, when the Muslim ruler Saladin attacked Palestine and took control of Jerusalem.

In the mid-1200's, Mamelukes based in Egypt established an empire that in time included Palestine. Arab Muslims made up most of Palestine's population. Beginning in the late 1300's, Jews from Spain and other Mediterranean lands settled in Jerusalem and other parts of Palestine. The Ottoman Empire defeated the Mamelukes in 1516, and Palestine became part of the Ottoman Empire. The Jewish population slowly increased, and by 1880, about 24,000 Jews were living in Palestine.

The Zionist movement. Beginning in the late 1800's, oppression of Jews in Eastern Europe set off a mass emigration of Jewish refugees. Some Jews formed a movement called *Zionism,* which sought to make Palestine an independent Jewish nation. The Zionists established farm colonies in Palestine. At the same time, Palestine's Arab population grew rapidly. By 1914, the total population of Palestine stood at 700,000. About 615,000 people were Arabs, and 85,000 were Jews.

World War I and the Balfour Declaration. During World War I (1914-1918), the Ottoman Empire joined Germany and Austria-Hungary against the Allies. An Ottoman military government ruled Palestine. Britain and some of the European Allies planned to divide the Ottoman Empire among themselves after the war. The Sykes-Picot Agreement of 1916 called for part of Palestine to be placed under a joint Allied government. Britain offered to back Arab demands for postwar independence from the Ottomans in return for Arab support for the Allies. In 1916, some Arabs revolted against the Ottomans in the belief that Britain would help establish Arab independence in the Middle East. The Arabs later claimed that Palestine was included in the area promised to them, but the British denied this.

In 1917, in an attempt to gain Jewish support for its war effort, Britain issued the Balfour Declaration. The declaration stated Britain's support for the creation of a Jewish national home in Palestine, without violating the civil and religious rights of the existing non-Jewish communities.

After the war, the League of Nations divided much of the Ottoman Empire into *mandated territories* (see **Mandated territory**). In 1920, Britain received a provisional mandate over Palestine, which would extend west and east of the Jordan River. The British were to help the Jews build a national home and promote the creation of self-governing institutions. In 1922, the League declared that the boundary of Palestine would be limited to the area west of the river. The area east of the river, called Transjordan (now Jordan), was made a separate British mandate. The two mandates took effect in 1923.

The terms of the Palestine mandate were not clear, and various parties interpreted it differently. Many Zionists believed that Britain did not do enough to promote a Jewish national home. They especially opposed restrictions set by the British on Jewish immigration and land purchases. The British hoped to establish self-governing institutions, as required by the mandate. But their proposals for such institutions were unacceptable to the Arabs, and so none were created.

The Arabs opposed the idea of a Jewish national home. They feared that the British were handing Palestine over to the Zionists by allowing too many Jews to immigrate to Palestine. During this period, a Palestinian Arab national movement first appeared. On several occasions, riots and demonstrations were mounted by the Arabs to protest British policies and Zionist activities.

In the early 1930's, over 100,000 Jewish refugees came to Palestine from Nazi Germany and Poland. This development alarmed the Palestinian Arabs. The Arabs organized a general uprising that almost paralyzed Palestine during the late 1930's. In 1939, the British began to drastically limit Jewish immigration and land purchases for the next five years. Any Jewish immigration after that would depend on Arab approval.

World War II and the division of Palestine. During World War II (1939-1945), many Palestinian Arabs and Jews joined the Allied forces. After the war, the Zionists used force to stop Britain from limiting Jewish immigration into Palestine. The Zionists wanted the British to allow immigration of several hundred thousand Jewish survivors of the *Holocaust,* the mass murder of European Jews and others by the Nazis.

The United Nations Special Commission on Palestine recommended that Palestine be divided into an Arab state and a Jewish state. The commission called for Jerusalem to be put under international control. The UN General Assembly adopted this plan on Nov. 29, 1947. The Jews accepted the UN decision, but the Arabs rejected it. Fighting broke out immediately.

On May 14, 1948, the Jews proclaimed the independent state of Israel, and the British withdrew from Palestine. The next day, neighboring Arab nations attacked Israel. When the fighting ended in 1949, Israel held territories beyond the boundaries set by the UN plan. The rest of the area assigned to the Arab state was occupied by Egypt and Jordan. Egypt held the Gaza Strip and Jordan held the West Bank. About 700,000 Arabs fled or were driven out of Israel and became refugees in neighboring Arab countries.

The continuing conflict and peace efforts. The UN arranged a series of cease-fires between the Arabs and the Jews in 1948 and 1949. Full-scale wars broke out again in 1956 and 1967. By the time the UN cease-fire ended the 1967 war, Israel had occupied the Gaza Strip and the West Bank. Israel also held Egypt's Sinai Peninsula and Syria's Golan Heights. In October 1973, Egypt and Syria launched a war against Israel. Cease-fires ended most of the fighting within a month.

The 1967 war brought about a million Palestinian Arabs under Israeli rule. After the war, the fate of the

Palestinians played a large role in the Arab-Israeli struggle. In time, the Palestine Liberation Organization (PLO) became recognized by all the Arab states as the representative of the Palestinian people. Israel strongly opposed the PLO because of its terrorist acts against Jews.

In 1978, Egypt and Israel signed an agreement designed to settle their disputes. Israel withdrew from the Sinai Peninsula in 1982. The agreement included provisions for a five-year period of self-government for the residents of the Gaza Strip and the West Bank. This period was to be followed by a decision about the future status of these territories. But no arrangement for such self-government was made following the agreement.

Beginning in 1987, Arabs in the Gaza Strip and West Bank staged several violent protests that became known as the first *intifada,* which means *uprising* in Arabic. Israeli troops killed a number of protesters. In the 1990's, Israel and the PLO signed agreements that led to the withdrawal of Israeli troops from the Gaza Strip and parts of the West Bank. As the Israelis withdrew, Palestinians took control of these areas. In 1996, Palestinians in these areas elected a legislature and president.

Peace talks between Israeli and Palestinian leaders continued in 2000, but the two sides could not agree on key issues. That year, Palestinians began a second intifada. Attacks by Palestinian militias and suicide bombers took place throughout Israel, the West Bank, and the Gaza Strip, killing hundreds of Israelis. Israeli forces repeatedly bombed and invaded the West Bank and Gaza Strip, killing more than 1,700 Palestinians. In 2002, Israel reoccupied much of the West Bank. Michel Le Gall

See also **Israel; Jordan;** and **Bible**, and their *Related articles;* **Palestine Liberation Organization; Arab-Israeli conflict.**

Additional resources

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Mattar, Philip, ed. *The Encyclopedia of the Palestinians.* Facts on File, 2000.

Palestine Liberation Organization (PLO) is the political body that represents the Arab people of Palestine. Its chief goal is to establish a state in Palestine for these Arabs. Palestine is a historic region that now consists of Israel, the West Bank, and the Gaza Strip.

About 700,000 Palestinian Arabs became refugees as a result of the Arab-Israeli war of 1948, when the state of Israel was founded. Today, there are more than 8 million Palestinian Arabs. More than 4 million of them live outside what was Palestine. The PLO includes guerrilla groups and associations of doctors, laborers, lawyers, women, students, and teachers. A number of Palestinian Arabs are independent members of the PLO. Guerrilla groups, primarily *Al Fatah,* dominate the organization.

Organization. The main organs of the PLO are the Executive Committee, the Central Committee, and the Palestine National Council. The Executive Committee is the main decision-making body. It consists of representatives of the major guerrilla groups and some independent members. The Central Committee, which includes representatives of all guerrilla groups, acts as an advisory group to the Executive Committee. The Palestine National Council, which has about 180 members, serves as the assembly of the Palestinian people.

History. The PLO was founded in 1964. In 1974, the Arab governments and the United Nations (UN) recognized the PLO as the representative of the Palestinian Arabs. The PLO did not recognize Israel's right to exist.

Since the 1960's, PLO guerrilla groups have staged attacks against Israel from time to time. Israel, in turn, has attacked PLO bases. From 1965 to 1971, the PLO operated from Jordan, where it also challenged the rule of King Hussein of Jordan. But Jordanian army forces drove out the PLO in 1970 and 1971. The PLO then moved to Lebanon and continued to attack Israel. In 1982, Israel drove the PLO out of southern Lebanon and Beirut. After Israeli troops withdrew from most of Lebanon in 1985, some PLO members returned to southern Lebanon.

Yasir Arafat became PLO chairman in 1969. In 1983, Syria supported rebels within the PLO who opposed Arafat's leadership. The rebels drove Arafat and his PLO forces out of northern Lebanon. In the mid-1980's, the PLO was seriously weakened by its internal conflicts, Israeli opposition, and conflicts with important Arab governments. But the Palestinian people and most Arab governments continued to support Arafat and the PLO.

In 1987, Palestinians in the West Bank and Gaza Strip began violent protests known as the first *intifada.* The PLO supported the Palestinians. Israeli troops assassinated the top PLO official responsible for the support.

Until 1988, Jordan provided the West Bank with financial and administrative support. But in July of that year, King Hussein announced that his country would end its support. He called on the PLO to take over Jordan's role in the West Bank. In late 1988, Arafat announced the PLO's recognition of Israel's right to exist alongside a Palestinian state. He renounced the use of terrorism. But some PLO members opposed to Arafat continued to launch terrorist attacks against Israeli targets.

In 1991, the Lebanese Army defeated PLO forces in southern Lebanon. Afterward, most PLO members left their military bases there, but the PLO continues to have influence in Palestinian refugee camps in Lebanon.

Peace talks between Israel, a number of Arab countries, and the Palestinians began in late 1991. Only Palestinians from the occupied territories were allowed to participate. PLO leaders advised the Palestinians during the talks. But separate discussions between the PLO and Israel took place. In 1993, the PLO and Israel recognized each other and signed an agreement that included steps to end their conflicts. As a result of this and later agreements, Israel withdrew from most of the Gaza Strip and parts of the West Bank. As the Israelis withdrew, Palestinians took control of these areas. In 1996, Palestinians in these areas elected a legislature and a president. Arafat was elected president of the new Palestinian Authority. Though the PLO continues to function as the representative of the entire Palestinian people, the Palestinian Authority has gained influence at the PLO's expense.

Peace talks between Israeli and Palestinian leaders in 2000 failed to resolve key remaining issues between the two sides. That year, Palestinians began another intifada. Attacks by Palestinian militias and suicide bombers took place throughout Israel, the West Bank, and the Gaza Strip, killing hundreds of Israelis. Israeli forces repeatedly bombed and invaded the West Bank and Gaza Strip, killing more than 1,700 Palestinians. In 2002, Israel reoccupied much of the West Bank. Michael C. Hudson

See also **Arafat, Yasir; Palestine.**

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Palestinians are an ethnic and national group native to the historic region of Palestine that now consists of Israel, the West Bank, and the Gaza Strip. Today, there are about 8 million Palestinians. Nearly half now live outside what was Palestine—in nearby Arab countries and elsewhere. Most of these Palestinians are refugees or the descendants of the more than 700,000 refugees who fled or were driven out of Israel when it was created in 1948. Some are people who were forced to leave the Gaza Strip and the West Bank, which were occupied by Israel in 1967. Today, though some Palestinians still live in refugee camps, most have integrated socially and economically within the host countries.

Modern Palestinians claim to be descendants of the *Philistines,* an ancient people who settled the region near the end of the 1200's B.C., and other groups who arrived later. Arab culture became a dominant influence beginning about A.D. 638 , when Muslim Arabs conquered much of the region. Palestinians today speak Arabic with regional accents that distinguish them from other Arab groups. Nearly all Palestinians are Muslims, with a large Christian minority.

The Palestinian people began to develop a modern national identity around 1900. Palestinian national identity has a number of sources. It comes in part from the religious attachment of Muslims and Christians to Palestine as a holy land. Palestinian nationalism and the desire for self-determination also developed as a response to *Zionism,* a movement that began in the 1800's and called for a Jewish national state in Palestine. In 1947, the United Nations voted to partition Palestine into a Jewish state and an Arab state. Jerusalem was put under international control. The Jews in Palestine accepted this plan, but the Arabs rejected it. Israel came into existence in 1948. War quickly broke out between Israel and the surrounding Arab countries. By 1949, Israel had won the war and taken control of about half the land planned for the new Arab state. Egypt and Jordan held the rest of Palestine. These areas came under Israeli control in 1967.

Today, Palestinians hold a variety of professional positions and are an important part of the economies of several Middle Eastern countries. About 2 million Palestinians are citizens of Jordan. Many others carry passports from the Palestinian Authority, which is the political body that administers Palestinian-controlled portions of the Gaza Strip and West Bank. About 1 million Palestinians are citizens of Israel, where they are subject to discrimination and many legal restrictions. Many Palestinians in Lebanon, Syria, and Egypt remain stateless refugees with no citizenship. Rashid I. Khalidi

See also **Arab-Israeli conflict; Israel** (History); **Palestine; Palestine Liberation Organization; Zionism.**

Palestrina, *PAL uhs TREE nuh* or *PAH lay STREE nah,* **Giovanni,** *joh VAHN nee* (1525?-1594), was one of the greatest composers of the Italian Renaissance. For the Roman Catholic Church, Palestrina wrote about 250 unaccompanied choral works called *motets,* and 93 masses. Two of his most famous works are the mass called *Missa Papae Marcelli* (about 1562) and his setting of the *Stabat Mater* (about 1563). He also composed unaccompanied nonreligious choral pieces called *madrigals.* The most famous is *Vestiva i colli* (1566).

Palestrina was a master of the *polyphonic* style of music, in which each voice has a separate melody. In his music, the voices imitate each other in graceful melodic curves, maintaining a steady rhythm. For contrast, the choir sometimes sings together in chords.

Palestrina took his name from his birthplace, the town of Palestrina, near Rome. His full name was Giovanni Pierluigi da Palestrina. Joscelyn Godwin

Palladio, *pahl LAH dyoh,* **Andrea,** *ahn DREH ah* (1508-1580), was an architect of the Italian Renaissance. He visited Rome frequently between 1541 and 1554, and he developed a great interest in and knowledge of ancient Roman architecture. That influence appears in his *Four Books of Architecture* (1570), an important work of Renaissance architectural theory. It also appears in his architectural works, notably in the Basilica in Vicenza (begun about 1547) and the Villa Rotonda (begun about 1567) near Vicenza. Palladio influenced architect Inigo



A Palladio church in Venice called San Giorgio Maggiore was designed in 1565 and completed in 1610, after the architect's death. The *facade* (front) features four giant columns topped by a triangular pediment in the style of an ancient Roman temple.

Jones in England in the 1600's and Georgian architecture in England in the 1700's and in the United States in the late 1700's and early 1800's. Palladio's influence reappeared in the late 1900's in a movement in Europe and the United States called Postmodernism.

Palladio was born on Nov. 30, 1508, in Padua. His real name was Andrea di Pietro della Gondola. The Italian scholar Giangiorgio Trissino named him Palladio after Pallas Athena, the Greek goddess of wisdom.

J. William Rudd

See also **Architecture** (picture: The Villa Rotonda; The Palladian revival); **Furniture** (The Palladian style); **Georgian architecture; Jones, Inigo.**

Palladium, *puh LAY dee uhm,* is a soft, shiny, silvery-white metal. It is one of six platinum metals, and is relatively rare. Palladium is often used in place of platinum because it is cheaper, harder, and lighter than platinum. It is found with deposits of other platinum metals, with nickel-copper ores, and with mercury.

Palladium can be drawn into wire or hammered into sheets. It is often mixed with gold to make "white gold" jewelry. It is also used to make surgical instruments.

Finely divided palladium, called *palladium black,* is used as a *catalyst,* a substance that causes or speeds up chemical changes. It is an important catalyst in a process called *hydrogenation,* which is used to improve the quality of oils and to prepare gasoline. Automakers use palladium, together with platinum and rhodium, in *catalytic converters.* These devices reduce the pollutants given off by auto engines (see **Catalytic converter**).

The English chemist William H. Wollaston discovered palladium in 1803. Its *atomic number* (number of protons in its nucleus) is 46. Its *relative atomic mass* is 106.42. A chemical element's relative atomic mass equals its *mass* (amount of matter) divided by $\frac{1}{12}$ of the mass of carbon 12, the most abundant form of carbon. Palladium melts at 1552 °C and boils at 2940 °C. Its density is 11.99 grams per cubic centimeter at 20 °C. S. C. Cummings

See also **Platinum.**

Pallas, or Pallas Athena. See **Athena.**

Palliative care is medical care provided to people dying of an incurable illness. Such care differs from *curative medicine,* which focuses on restoring health, or treatments for chronic illness, referred to as *supportive medicine.* The goal of palliative care is to provide comfort for the patient's remaining life and a peaceful death. Palliative care focuses on relieving the symptoms, particularly pain, of incurable illness. It also addresses the psychological, social, and spiritual needs of the patient, and provides support for the patient's family and caregivers.

Palliative care differs from physician-assisted suicide or *euthanasia* (helping or allowing people to die). It is not intended to be the direct cause of death. Supporters of palliative care believe that many terminally ill patients ask to die because they suffer from untreated pain, undiagnosed depression, despair, or social isolation. Medical studies have shown that dying patients often do not receive adequate treatment for pain and depression.

In palliative care, the caregivers acknowledge dying as a normal process and death as part of life. Once the medical team deems a patient's condition terminal, they turn away from attempts at cure and towards making the patient feel comfortable and ready to die peacefully. Hospice care is a form of palliative care.

John W. Finn

See also **Death; Hospice.**

Palm is a group of trees, vines, and shrubs that typically grow in warm and wet climates, especially in the tropics. Palms are among the most important plants in tropical regions because they provide food, drink, fibers, and building materials for the people.

Palms are most diverse and most common in Southeast Asia, the Pacific islands, and in tropical America. They grow wild as far north as Korea, Japan, and the states of North Carolina and California in the United States; and as far south as Argentina, central Chile, New Zealand, and South Africa. They also are cultivated on plantations in many tropical regions. Some palms live more than 100 years.

Palms are an ancient group of plants. Fossils of palm leaves have been found that date from the Age of Reptiles. Palms once grew in all parts of the world, and palm fossils have been found as far north as Greenland.

Kinds of palms. There are more than 2,800 kinds of palms, and they vary greatly in size and the kind of flowers, leaves, and fruits they produce. Most palms grow straight and tall. But the trunks of some palms may lie on the ground. Some have most of the trunk buried in the soil. The rattan palms found in the jungles of Southeast



E. R. Degginger



Lois Cox



E. R. Degginger

Most palms have a branchless trunk topped by a leafy crown. Canary Island date palms, *left,* have an especially dense crown. The trunk of the Washingtonia palm, *center,* is partly covered by a "skirt" of dead leaves. Royal palms, *right,* have a whitish trunk that resembles a concrete pillar.

Asia have slender, vinelike stems from 10 to 250 feet (3 to 76 meters) long. The stems may trail along the jungle floor or climb high in the trees. Most palms have a single trunk or stem. But many have clustered trunks that grow from the same root base.

The trunk is usually straight and round and from 4 to 24 inches (10 to 61 centimeters) thick. But some palms have trunks that are no thicker than a pencil, while others have trunks that are 5 feet (1.5 meters) thick. The trunk may range from a few inches or centimeters to well over 100 feet (30 meters) tall. The trunks of the larger palm trees grow from 1 to 4 feet (30 to 120 centimeters) a year. The trunk may have rough or smooth bark, and some have thorns. Only a few palms have branches growing from the trunk. A few kinds have a strawlike "skirt" of dead leaves that hangs down along the trunk. Most palms have their fanlike or featherlike leaves clustered at the top of the trunk.

The leaves vary greatly in size and appearance. The smallest leaves are less than 1 foot (30 centimeters) long. Most of the fanlike leaves are from 2 to 4 feet (60 to 120 centimeters) wide, and the featherlike types may be 20 feet (6 meters) long and from 1 to 4 feet (30 to 120 centimeters) wide. Two types produce the largest leaves. The talipot palm has fan-shaped leaves that may be 15 feet (4.6 meters) wide. The raffia palm's leaves may be 65 feet (20 meters) long and 8 feet (2.4 meters) wide. Mature leaves remain on a palm from one to nine years.

The fruits differ greatly in size and shape. Some fruits are no larger than a pea. The huge fruit of the double coconut palm may grow as large as 2 feet (60 centimeters) in diameter. The fruit of the palm contains from one to seven seeds. The flesh of the fruit may be soft, as in the date, or firm and threadlike, as in the coconut. The seed may be hard, as in the date. Only rarely is it soft, or even hollow and filled with "milk," as in the coconut. The double coconut and the true coconut have the largest of all known seeds. The male and female flowers of many kinds of palms are on different trees and depend on people, wind, or insects for fertilization.

Products of palms. Palms provide ornament, shade, building materials—both timbers and thatch—and fuel. Fibers for making ropes and brooms and for *caulking* (making watertight) ships are made from the palm. Strips of leaves are woven into mats, hats, and baskets. Oil for food and lighting comes from several species, particularly the oil palm. The sugary sap of such palms as the palmyra palm can be made into food, sweet drinks, and intoxicating beverages, such as *arak* (also spelled *arrack*). The starch of palms is used for food. The seeds are crafted into buttons and carvings. People chew betel palm seeds as a stimulant. A few palms have poisonous seeds.

The palm is most important to the people who live in the tropics. But people elsewhere also depend on palms for many useful products. The dried oily meat of the coconut is used to add flavor to cakes. Its rich oil is used in soap, salad oils, cooking fats, and margarine. Oil from the oil palm is used in cosmetics and in pharmaceutical creams and ointments. Dates are a familiar product of the date palm. Sago is a starch taken from palm trunks.

Many baskets and chair bottoms are woven from strips of palm leaves. The stems of the rattan palm are used in making furniture. Raffia is made of thin layers of cells stripped from the leaves of a Madagascar palm. It is used by children in basket making at school. Wax from the leaves of the carnauba palm of Brazil is used in such products as shoe polish. Michael G. Barbour

Scientific classification. Palms belong to the palm family, Palmae, also called Arecaceae.

Related articles in *World Book* include:

Palm products

Carnauba wax	Raffia	Sago
Palm oil	Rattan	

Types of palm trees

Betel	Date palm	Palmetto
Cabbage palm	Doum palm	Palmyra palm
Coconut palm	Ivory palm	Royal palm

Palm oil, made from the fruit of the oil palm tree, is a widely used vegetable oil. Taken together, palm oil and soybean oil account for about half of all vegetable oils produced throughout the world. Palm oil is used in making a variety of products, including ice cream, cooking oil, margarine, shortening, and soap.

The fruit of the oil palm tree is reddish-orange and about the size of a date. The tree produces 10 to 15 fruit clusters, each with about 200 fruits. The clusters are cut from the trees and taken by truck to a mill, where they are sterilized and separated into individual fruits. A machine called a *digester* converts the fruit into a mash, which is crushed to obtain crude palm oil. The crude oil is then dehydrated, cleaned, and refined.

During the 1700's, the English used palm oil as a medicine and hand cream. In the early 1900's, oil palm trees were planted in parts of Africa. Many rubber plantations in Indonesia and Malaysia were replanted with oil palms during the 1960's. Today, the two countries produce the majority of the world's palm oil. David E. Zimmer

Palm Springs (pop. 41,155) is a resort city in southern California surrounded by desert land and mountains. For location, see **California** (political map). The city is named for the palm trees that line its streets and its natural hot springs. These features—plus a warm climate, fashionable hotels and private houses, golf courses, and swimming pools—make Palm Springs a major tourist attraction. The Palm Springs Aerial Tramway carries passengers to near the top of nearby Mount San Jacinto.

About a fifth of the city's area is part of a reservation of the Agua Caliente Band of Cahuilla Indians. The Indians lived in the area long before it was settled by whites in the late 1800's. In the 1930's, Palm Springs became a popular resort for movie stars. The city has a council-manager form of government. James J. Rawls

Palm Sunday is the Sunday before Easter and the beginning of Holy Week in the Christian calendar. Palm Sunday worship recalls when people spread palms and clothing in front of Jesus as He entered Jerusalem. This procession took place several days before He was crucified. Palm Sunday marks a turn in Christian churches' observance of Lent from a time of discipline and sorrow for one's sins to a time of looking ahead to the *Passion* (suffering and death) of Jesus and His Resurrection.

By the late 300's, Christians in Jerusalem were celebrating Palm Sunday on the first day of Holy Week. It was part of a trend there to remember the last events of Jesus's life by holding services at sacred sites in the city. Today, Christians in many traditions observe Palm Sunday with the blessing and distribution of palms. Usually,

the ceremony includes a procession. David G. Truemper

See also Easter (picture: Palm Sunday).

Palma. See Gorée.

Palmares, *puhl MAH rihs,* was the largest and most famous community established by runaway slaves in Brazil during the 1600's. Through the years, it has become an important symbol of the black struggle for freedom in Brazil and other parts of the Americas.

Palmares was formed about 1605 and grew through the union of several *mocambos*—that is, settlements of runaway slaves. It lay in a rugged area of what is now northeastern Brazil. Eventually, Palmares was organized like an African kingdom, with a powerful elected king. Several relatives helped the king rule the community.

Palmares was composed primarily of African-born people from several ethnic groups, but it also attracted blacks born in Brazil. Estimates of the size of Palmares vary, but the kingdom was home to 11,000 to 20,000 people at its peak. The people of Palmares hunted and fished. They grew a variety of crops, including bananas, beans, cassava, corn, sweet potatoes, and sugar cane. They were skilled at various crafts, including pottery making, woodworking, and weaving.

Palmares withstood attacks from the Dutch, who took control of Brazil from Portugal in 1630, and from the Portuguese, who regained the colony in 1654. The Portuguese attacked almost annually from 1672 to 1694, when they finally destroyed the kingdom. Colin A. Palmer

Palmer, A. Mitchell (1872-1936), served as United States attorney general from 1919 to 1921 under President Woodrow Wilson. Palmer is best known for the *Palmer Raids* of January 1920, in which thousands of suspected anarchists and Communists were jailed with little regard for their constitutional rights. Many historians believe Palmer hoped to win the 1920 Democratic presidential nomination by capitalizing on the antiradical feelings that many Americans held at that time.

Alexander Mitchell Palmer was born on May 4, 1872, in Moosehead, Pennsylvania. He served in the U.S. House of Representatives from 1909 to 1915. As a member of the Democratic national committee in 1912, he helped Wilson win the presidential nomination.

David A. Shannon

Palmer, Alice Elvira Freeman (1855-1902), gained fame as an American educator. In 1879, at the age of 24, she became head of the history department at Wellesley College. Three years later, she became president of Wellesley. She was one of the youngest college presidents in history. She resigned as president in 1887 after she married George Herbert Palmer, a Harvard University professor. She served as the first dean of women at the University of Chicago from 1892 to 1895.

In 1882, she helped organize the Association of Collegiate Alumnae, which later became the American Association of University Women. She served as its president in 1885 and 1886. Alice Elvira Freeman was born on Feb. 21, 1855, in Colesville, New York. Nancy Woloch

Palmer, Arnold (1929-), an American golfer, became one of the greatest and most popular players in the history of the sport. Palmer was the first player to win the Masters Tournament four times—in 1958, 1960, 1962, and 1964. Palmer's appealing personality and bold playing style helped to greatly increase the popularity of golf. Throughout his career, Palmer has attracted a huge crowd of supporters called "Arnie's Army" at tournaments. His charisma also was largely responsible for making golf a popular television sport.

Arnold Daniel Palmer was born on Sept. 10, 1929, in Latrobe, Pennsylvania. Palmer turned professional after winning the United States Amateur tournament in 1954. He won the U.S. Open in 1960 and the British Open in 1961 and 1962. Palmer joined the Senior PGA Tour in 1980. Palmer's autobiography was published as *A Golfer's Life* (1999). Marino A. Parascenzo

See also Golf (picture).

Palmer, Joel (1810-1881), a Canadian-born statesman, won fame as a negotiator of important Indian treaties of 1854 and 1855. As superintendent of Indian affairs for the Oregon Territory from 1853 to 1857, he removed Indian tribes from areas of white settlement. The tribes were upset over losing their lands, but Palmer gave them new areas with generous hunting and farming rights. He was removed from office because many whites believed he was too kind to the Indians. Palmer's *Journal of Travels over the Rocky Mountains* (1847) became a guidebook for travelers. It gives a fine description of a trip on the Oregon Trail. Palmer was born on Oct. 4, 1810, in Ontario. Dan L. Flores

Palmer, Nathaniel Brown (1799-1877), was an American sea captain. He may have been the first explorer to sight Antarctica (see Antarctica [Early exploration]). In 1820, while looking for seal-fishing grounds, he took his sloop, the *Hero,* south from Yankee Harbor in the South Shetland Islands. He sighted the Antarctic Peninsula, an arm of Antarctica extending toward South America. He believed it was only an island. In 1821, he and Captain George Powell, a British sealer, were the first explorers to sight the South Orkney Islands. Palmer was born on Aug. 8, 1799, in Stonington, Connecticut. William Barr

Palmer, Potter (1826-1902), a merchant and real estate promoter, revolutionized the selling methods of his day. Using the "Palmer System," his store in Chicago let customers take home merchandise and inspect it, and make exchanges or get refunds. About 1865, Marshall Field and Levi Z. Leiter became partners in the business. They bought Palmer out two years later. In 1881, the business became Marshall Field and Company. Palmer built the Palmer House, a famous Chicago hotel, and was a leader in developing Chicago's State Street as one of the world's major retail centers. Palmer was born on May 20, 1826, in Albany County, New York. John N. Ingham

Palmerston, *PAH muhr stuhn,* **Viscount** (1784-1865), was a distinguished foreign secretary and prime minister of the United Kingdom. He became secretary of state for foreign affairs in 1830 and, except for a short interval, held the post until 1841. After a five-year absence, he returned to the foreign office in the cabinet of Lord John Russell. He established friendly relations with France, helped Belgium gain independence, and supported Turkey against Russia. Russell dismissed him in 1851. Without consulting his cabinet colleagues or Queen Victoria, Palmerston had approved the seizure of power in France by Napoleon III.

Palmerston's aggressive foreign policy was popular in the United Kingdom, though criticized abroad and in Parliament. He believed in the United Kingdom's greatness in the world and demanded respect for his country from other nations. In one speech, he reminded his lis-

teners that a citizen of ancient Rome was safe anywhere in the Roman Empire, and declared that the United Kingdom would also protect its subjects the world over.

Palmerston became prime minister in 1855. He saw the Crimean War to a successful end but resigned in 1858 because of criticism of his policy in China. He was prime minister again from 1859 until his death.

Palmerston was born on Oct. 20, 1784, at Broadlands, in the county of Hampshire, England. His full name was Henry John Temple. He won election to the House of Commons in 1807, and two years later became secretary at war. He held this office for 19 years. Denis Judd

Palmetto, *pal MEHT oh,* is the name of a group of about 20 species of palm trees. Palmettos grow in Bermuda, the West Indies, Central America, the southeastern part of the United States, and northern South America. They range in height from 6 to 90 feet (1.8 to 27 meters), depending on the species. Palmettos have fan-shaped leaves, which can be used to make baskets, mats, and thatch for huts. The palmetto is the state tree of South Carolina. See also **Cabbage palm; South Carolina** (picture: The state tree). James D. Mauseth

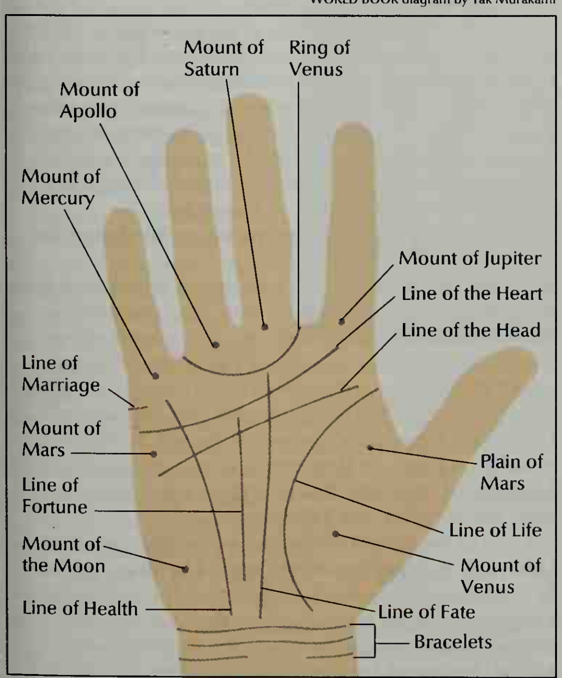
Scientific classification. Palmettos belong to the palm family, Arecaceae or Palmae.

Palmistry, *PAH muh stree,* is the practice of foretelling the future by examining the lines and marks of the human hand. Palmistry, sometimes called *chiromancy,* probably began in ancient India. It was once considered a science. Today, most people regard palmistry as a *pseudoscience* (false science). But people in many parts of the world practice palmistry.

Features of the hand in palmistry

This chart shows the major features of the hand used in reading palms. Palmists study the wrinkles, called *lines,* and the fleshy pads, called *mounts.* These features, palmists claim, can reveal a person's character and foretell his or her future.

WORLD BOOK diagram by Tak Murakami



In palmistry, the fleshy parts of the palm at the base of the thumb and fingers and on the side of the hand are called *mounts.* The mounts are named for Apollo, the god of the sun in Greek and Roman mythology; the moon; and the planets Venus, Jupiter, Saturn, Mercury, and Mars. A well-developed, fleshy mount supposedly means that a person has the characteristics associated with that mount. For example, the mount of Apollo indicates art and riches. Jupiter signifies ambition and pride, and Venus represents love and music.

The wrinkles on the palm are called *lines.* Like the mounts, each line has a name and a meaning. For example, a long line of life supposedly foretells a long life. A long, clear line of the heart indicates an affectionate disposition. A strongly marked line of the head signifies intelligence and imagination.

Many palmists also use various physical and psychological clues in making predictions. Nervousness or small muscular reactions to statements made by the palmist may reveal a person's feelings. The condition of the hands and nails also indicates some characteristics. Such signs may help the palmist make surprisingly accurate predictions. Some palmists use the form of the hand to describe an individual's personality as part of the process of predicting the future. Many of the people who believe in palmistry try to connect it with other occult practices, such as *astrology* (fortunetelling by the stars and planets). Marcello Truzzi

See also **Fortunetelling.**

Palmyra, *pal MY ruh,* was an ancient Syrian city, about midway between the eastern coast of the Mediterranean Sea and the Euphrates River. Palmyra was built around an oasis on an important trade route between the Roman and Persian empires. Caravans stopped at Palmyra, bringing great riches and a variety of people and cultures. The temple of Palmyra's chief god, Bel, is typical of the mixture of cultures. Although Bel was an eastern god, the temple's architecture is Roman.

By the A.D. 160's, Palmyra had come under Roman control. Palmyrene camel troops served in the Roman army. Roman troops helped protect Palmyra. However, when Persia invaded Syria about 260, Rome had no troops to spare for Syria's defense. Under Septimius Odenathus, a Palmyrene prince, Palmyrene forces turned back the invading Persians. In 262, Odenathus became Rome's supreme military commander on the eastern frontier. He died in 267, and his widow Zenobia succeeded him.

Zenobia, a vigorous and able ruler, tried to extend her rule over Egypt and all Asia Minor. Her troops seized land from Rome. But the Roman emperor Aurelian captured Zenobia in 274 and destroyed Palmyra. Emperor Diocletian partly restored the city in the late 200's. In the mid-500's, Emperor Justinian used it as a fortress to defend the eastern frontier against Persia. Palmyra fell into decline after Arab forces gained control in 637.

Clive Foss

See also **Syria** (picture: Ruins of Palmyra).

Palmyra palm, *pal MY ruh,* is a kind of palm that grows throughout India and nearby islands and in other hot countries. It is one of the most useful plants known. Lumber from the trunk of the palmyra palm is used for building houses. The leaves are made into thatch, baskets, mats, hats, fans, and umbrellas. The fiber of the

plant is used for twine and rope. The fruit, seeds, and young stalks are eaten. In the northern part of Sri Lanka, the palmyra is almost the sole source of livelihood for thousands of the people.

The ancient Hindu scholars used strips from the leaves of the palmyra and talipot palms for writing material. Some of the oldest existing Hindu manuscripts are preserved in books made of these strips. The books are 1 to 2 feet (30 to 61 centimeters) long and never more than 2 inches (5 centimeters) wide. James D. Mauseth

Scientific classification. Palmyra palms belong to the palm family, Arecaceae or Palmae. Their scientific name is *Borassus flabellifer.*

Palo Alto, *PAL oh AL toh,* California (pop. 58,598), lies between San Francisco Bay and the Santa Cruz Mountains. It is 32 miles (51 kilometers) south of San Francisco and 14 miles (23 kilometers) north of San Jose (see **California** [political map]). Palo Alto means *tall tree* in Spanish. This refers to a tall coastal redwood, a landmark at the northwest entrance to the city.

Palo Alto is one of the nation's leading educational, electronics, medical, and research centers. Stanford University is nearby. The area from Palo Alto southeast to San Jose is called Silicon Valley because of its many computer-related industries. It is so named because silicon is used to make computer chips.

Palo Alto was founded in 1888 and called University Park. In 1892, its name was changed to Palo Alto. The city has a council-manager government. James J. Rawls

Palomar Observatory, *PAL uh mahr,* is an astronomical observatory in southwestern California, about 45 miles (72 kilometers) northeast of downtown San Diego. It stands atop Palomar Mountain, 5,597 feet (1,706 meters) above sea level. The observatory is best known for the Hale telescope, one of the world's largest *optical telescopes.* (An optical telescope collects and focuses visible light given off, or reflected, by celestial objects [see **Telescope**].) The Hale telescope was named for American astronomer George Ellery Hale, who planned its construction (see **Hale, George Ellery**).

In 1963, astronomers using the Hale telescope first identified *quasars,* extremely bright objects in the center of some distant galaxies (see **Quasar**). Energy from quasars takes billions of years to reach the earth. For this reason, the study of quasars can provide information about early stages of the universe.

The Hale telescope is a *reflecting telescope* (one that collects and focuses light with a concave mirror). Its mirror is 200 inches (508 centimeters) in diameter. This telescope can also be equipped with detectors for observation and photography with *infrared rays* (heat rays). One major use of these detectors is the study of stars in the process of formation. Palomar also has a reflecting telescope with a 60-inch (152-centimeter) mirror.

In addition, the observatory has two *Schmidt telescopes.* These telescopes are instruments with both a large mirror and a large lens. The bigger of the two telescopes, called the Oschin telescope, has a 72-inch (183-centimeter) mirror and a 48-inch (122-centimeter) lens. This telescope, built to map the sky and locate celestial bodies for detailed study with the Hale telescope, can photograph an area of the sky about 200 times as large as the area that the Hale telescope can map. However, the Hale telescope provides images with greater detail.

During the 1950's, astronomers used the Oschin telescope to map millions of stars and galaxies. This survey revealed the distant sources of light that later were discovered to be quasars. In 1982, astronomers began to repeat this survey, using more sensitive photographic plates. The Palomar Observatory began operations in 1948. It is owned by the California Institute of Technology. Critically reviewed by the Palomar Observatory

See also **Mount Wilson Observatory.**

Palomino horse. See **Horse** (Color types; picture: Palomino).

Paloverde, *PAH loh VAIR day,* is the name of two species of thorny trees that grow in the dry regions of the Southwestern United States. Paloverdes grow along the sides of desert canyons and dry stream beds in southern and central Arizona, southeastern California, and northwestern Mexico. Both species—the *blue paloverde* and the *foothill paloverde*—represent the state tree of Arizona.

A paloverde grows from 15 to 30 feet (4.6 to 9 meters) tall and its trunk may be up to 20 inches (51 centimeters) in diameter. It has green bark and leaves about 1 inch (2.5 centimeters) long that unfold in late March or April. The leaves fall almost as soon as they are full grown, and the tree is usually bare by late summer. In late April and May, paloverdes bear small yellow flowers.

A paloverde produces seed pods 2 to 3 inches (5 to 8 centimeters) long. Each pod usually contains two to four large seeds. Indians once dried the seeds and ground them into meal, or ate immature seeds raw. Paloverdes have little commercial value. But the roots help hold loose desert soil together and slow *erosion* (wearing away) of the soil. Donald J. Pinkava

Scientific classification. Paloverdes belong to the pea family, Fabaceae or Leguminosae. The scientific name for the blue paloverde is *Cercidium floridum.* The foothill paloverde is *C. microphyllum.*

Palpitation. See **Tachycardia.**

Palsy, *PAWL zee,* means the same as *paralysis,* the loss of movement or sensation (see **Paralysis**). The term *palsy* is most commonly used in connection with certain types of paralysis. Some kinds of palsy are caused by continued pressure on a nerve. Shaking palsy *(paralysis agitans),* an involuntary tremor of the muscles, is another name for Parkinson disease. *Chemopallidectomy* is an operation for this tremor. Daniel S. Barth

See also **Bell's palsy; Cerebral palsy; Parkinson disease.**

Pamirs, *pah MEERZ,* is a huge region where the Himalaya, Hindu Kush, Kunlun, and Tian Shan mountains meet. It is one of the highest mountain ranges of the world. The region is sometimes called *Bam i Dunya,* which means *roof of the world.* It lies mostly in Tajikistan, but parts of the region extend into Afghanistan, China, and Kyrgyzstan. The region covers 36,000 square miles (93,200 square kilometers), at an average height of 13,000 to 15,000 feet (3,960 to 4,570 meters) above sea level. For location, see **Tajikistan** (map).

Most of the Pamirs is treeless, with either grass or bare rock. Rugged mountains are cut by deep canyons. In summer, native people find pasture for their cattle on the gentler slopes along the few lakes and the *Amu Darya* (Oxus River). Snow covers the mountains and blocks the passes for more than half of each year. High

winds blow across the mountains during the summer months. James A. Hafner

See also **Asia** (Mountains); **Hindu Kush**.

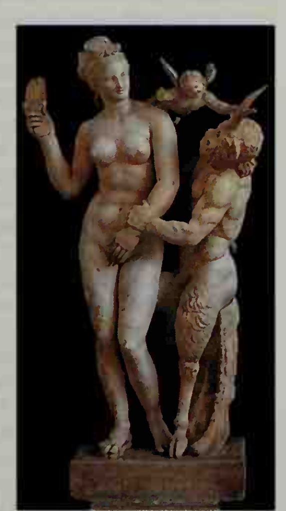
Pampa, *PAM puh,* is a Spanish word that means *plain.* Geographers use the word *pampa* for several great plains of South America. But it is most commonly used for the huge plain in Argentina that fans out around Buenos Aires. An area of fertile soil and much grassland, the Argentine Pampa yields abundant crops and supports livestock. It is also the site of most of Argentina's urban areas. More than two-thirds of Argentina's people live on the Pampa. See also **Argentina** (terrain map; The Pampa; Agriculture). Jerry R. Williams

Pamphlet is a short published work of topical interest through which the writer wishes to inform or persuade the public. A pamphlet is usually bound in paper covers. Pamphlets originally consisted of manuscripts bound in covers. The word *pamphlet* comes from *Pamphilius, seu de Amore,* a Latin poem published in this form in the 1100's. Most early pamphlets discussed religious questions. Political issues formed the subject matter of pamphlets during the 1600's and 1700's. Charles F. Sieger

Pan was the god of woods and pastures in Greek mythology. He also was the protector of shepherds and their flocks. Shepherds and farmers prayed to Pan to make their animals fertile.

Pan was half man and half goat. The ancient Greeks believed he had a wild, unpredictable nature. They also thought he had the power to fill human beings and animals with sudden, unreasoning terror. The word *panic* comes from his name.

The Greeks associated Pan with wilderness regions. They believed he lived in caves, on mountain slopes, and in other lonely places. The worship of Pan began in Arcadia, a remote region of southern Greece. Pan's father, Hermes, also was associated with Arcadia. The worship of Pan spread until he became one of the most popular gods.



Marble sculpture (A.D. 1-99); National Museum of Athens (Art Resource)

The Greek god Pan was half man and half goat. He had many love affairs with divinities. In this sculpture, he is with Aphrodite, *left,* and Eros, *center,* the goddess and god of love.

Pan had many love affairs with nymphs and other divinities (see **Nymph**). He tried to start an affair with the nymph Syrinx, but she ran away from him in terror and begged the gods to help her. The gods changed Syrinx into a bed of reeds, from which Pan made a musical instrument called a *panpipe.* He became famous for the beautiful music he played on the panpipe. C. Scott Littleton

See also **Faun**.

Pan-American conferences have brought together representatives from countries of North, Central, and South America. These meetings also have been called *Inter-American conferences.* Through them, the nations have worked to create closer and more friendly economic, cultural, and political relations with one another.

The original Pan-Americanism. Simón Bolívar, a South American statesman, took the first steps toward setting up an arrangement among American republics (see **Bolívar, Simón**). Through his efforts, various independent American countries held their first conference in 1826 in Panama City, Panama. Other conferences took place in Lima, Peru, in 1847; in Santiago, Chile, in 1856; and in Lima in 1864. These meetings attracted delegates from Spanish American republics and focused on political issues, such as cooperation among the countries in the defense of their national sovereignty.

The "new" Pan Americanism. By 1889, the United States had begun to exercise leadership in inter-American affairs. That year, U.S. interest in expanding trade with Latin America led to the First International Conference of American States, also known as the *Pan-American Conference,* in Washington, D.C. The conference established the International Union of American Republics, with the Commercial Bureau of the American Republics as its central office. In 1910, the bureau became the Pan American Union. The five conferences between 1889 and 1933 met under a cloud of fear of the United States. During this time, the United States interfered in the affairs of several Latin American countries, often by force.

"Good Neighbor" Policy. United States President Herbert Hoover realized the need for better relations between the United States and Latin American countries. However, significant progress toward that goal occurred only after Hoover's successor, Franklin D. Roosevelt, established the Good Neighbor Policy. This policy affirmed that no nation had a right to interfere in the affairs of another nation. The United States endorsed the policy at conferences in Montevideo, Uruguay, in 1933 and in Buenos Aires, Argentina, in 1936. The Good Neighbor Policy led to increased cooperation between the United States and Latin American countries during World War II (1939-1945).

Stronger ties. Representatives at a Mexico City meeting in 1945 sought to further strengthen the Inter-American system. The first step in this direction was a treaty to meet acts of aggression. In a 1947 conference held near Rio de Janeiro, representatives drew up the Inter-American Treaty of Reciprocal Assistance, or *Rio Treaty,* which declared that an armed attack on one member was an attack against all.

An Inter-American Conference held at Bogota in 1948 resulted in the establishment of the Organization of American States (OAS). The Pan American Union became the permanent body of the OAS and eventually was named the organization's General Secretariat.

After 1948, Cold War issues often dominated the Inter-American conferences. These issues included ways to achieve political reform and economic growth in the Western Hemisphere to help stop the spread of Communism. In 1960, the OAS took its first collective action against a country. It imposed diplomatic sanctions against the Dominican Republic, then under the control of dictator Rafael Trujillo.

In 1961, the United States and Latin American countries established the Alliance for Progress. This pro-

gram, proposed by U.S. President John F. Kennedy, called for social and economic development based on democracy and capitalism. But the program failed to end Communist rule in Cuba or the Communist movements in some other Latin American countries. Communists had gained power in Cuba in 1959.

In 1962, the OAS unanimously supported a United States naval quarantine aimed at preventing Soviet nuclear weapons from entering Cuba. In 1969, an OAS conference of foreign ministers acted quickly to end an invasion of Honduras by troops from El Salvador.

Amendments to the OAS charter went into effect in 1970. They provided for a General Assembly that would meet annually. The General Assembly replaced the Inter-American Conference, which had usually held regular sessions every five years. Since the late 1970's, the OAS has struggled to reduce revolutionary and other political turmoil in Central America. But it has had little effect. Mark T. Gilderhus

See also **Alliance for Progress; Organization of American States; Pan American Highway.**

Pan American Games are a series of athletic contests patterned after the Olympic Games and sponsored by the Pan American Sports Organization (PASO). PASO is made up of Western Hemisphere nations. The games are held once every four years, usually the year before the summer Olympic Games. For more information, see **Olympic Games.**

The Pan American Games were inaugurated after World War II by the Pan American Sports Congress, which became PASO in 1967, as a way to increase good will among the countries of the Americas. The first Pan American Games were held in Buenos Aires, Argentina, in 1951. Dave Nightingale

Pan American Highway is a system of highways that extends from the United States-Mexican border to southern Chile. It also connects the east and west coasts of South America, and links the capitals of 17 Latin American countries. The 29,525-mile (47,516-kilometer) system benefits Latin America's economy. It provides a route for raw materials and agricultural products through much of Latin America. The Pan American Highway is sometimes described as running through the western United States and Canada up into Alaska. But neither country has officially named any highway as part of the Pan American Highway system.

Route. The Pan American Highway has four major U.S. terminals: Nogales, Arizona; and Eagle Pass, El Paso, and Laredo, Texas. It crosses Mexico, Guatemala, El Salvador, Honduras, Nicaragua, and Costa Rica, and into Panama. The Darien Gap, a stretch of about 70 miles (110 kilometers) of jungle, blocks the highway at Yaviza, Panama. Motorists usually ship their cars from either Cristobal or Balboa, Panama, to Colombia or Venezuela. South of the gap, the highway follows the western coastline of South America to Puerto Montt, Chile.

At Santiago, Chile, about 660 miles (1,060 kilometers) north of Puerto Montt, a major branch of the highway cuts eastward across the Andes Mountains to Buenos Aires, Argentina. It then follows the east coast of South America north to Rio de Janeiro, Brazil, where it turns inland to Brasilia, the capital of Brazil. Other branches of the highway lead to the capitals of Bolivia (La Paz and Sucre), Paraguay (Asunción), and Venezuela (Caracas).



WORLD BOOK map

The Pan American Highway provides a route through much of Latin America for raw materials and agricultural products.

Development. The idea to link North and South America dates from the late 1800's, when people talked of building a Pan American railway. But it was not until 1923, at the Fifth International Conference of American States, that a highway was seriously considered. This conference led to the First Pan American Highway Congress at Buenos Aires in 1925.

Organization of the system started in the late 1920's. By 1940, over 60 percent of the highway between the United States and Panama had been completed. By the early 1950's, most of the project was open to travel in South America. An important link in the system opened in 1962, when the Thatcher Ferry Bridge was completed over the Panama Canal at Balboa. The bridge is 1 mile (1.6 kilometers) long and is one of the world's longest steel arch bridges.

Each South American country has financed the building of the highways within its own borders. In 1930, the United States began giving financial support to speed the building of the Pan American Highway between Panama and Texas. This section is also called the Inter-American Highway. The United States has contributed two-thirds of the cost of building this part of the highway. Only Mexico has not used United States financial aid in building the system.

The Pan American Highway Congress, sponsored by the Organization of American States (OAS), meets every four years to discuss the development and progress of the highway system. The congress has headquarters in the General Secretariat of the OAS in Washington, D.C.

Critically reviewed by the General Secretariat, Organization of American States

See also **South America** (Transportation [picture]).

Pan American Union. See **Organization of American States; Pan-American conferences; Pan American Highway.**

Panama

Panama is a small country in Central America that has worldwide importance as a transportation center. It covers the Isthmus of Panama, a narrow strip of land that separates the Atlantic and Pacific oceans near the middle of the Western Hemisphere. The Panama Canal cuts through the isthmus, connecting the two oceans. Thousands of ships use the canal each year to pass from one ocean to the other. By doing so, they avoid a long trip around the southern tip of South America. Thus, Panama plays a key role in the world's transportation system. The country is sometimes called the *Crossroads of the World* because of this role.

Panama lies at the southern end of North America. It and the land north of it to Mexico's southern border make up the part of the North American continent called Central America. Panama is a narrow country that curves from west to east. The Atlantic Ocean lies to the north, the Pacific Ocean to the south, Colombia to the east, and Costa Rica to the west.

Lowlands cover the part of Panama near the Atlantic and Pacific coasts. The Atlantic coast is sometimes referred to as the Caribbean coast because it borders the part of the Atlantic Ocean that is called the Caribbean Sea. Mountains cover much of Panama's interior, and there are jungles and swamps in the east. Panama City is the country's capital and largest city.

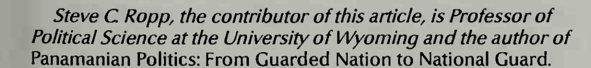
Mestizos (people of mixed American Indian and white ancestry) and *mulattoes* (people of mixed black and white ancestry) make up more than two-thirds of Panama's population. Most of the rest of the people are of unmixed American Indian, black, or white ancestry.

Indians were the first inhabitants of what is now Panama. Spaniards conquered the Indians during the 1500's and ruled Panama for about 300 years. In 1821, Panama broke away from Spain and became a province of the nation of Colombia. In 1903, it rebelled against Colombia and became an independent nation.

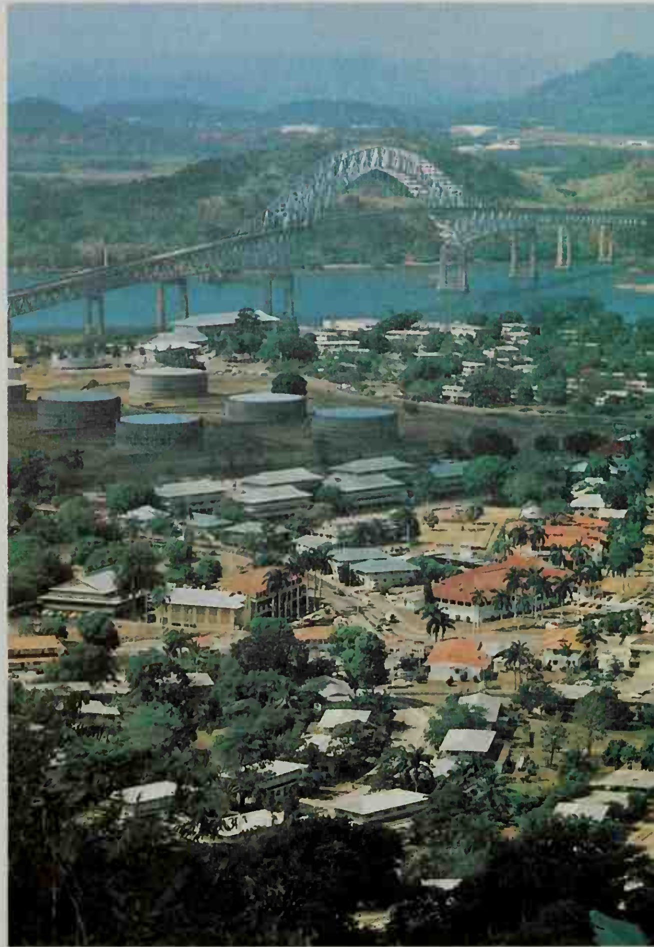
The United States played a major role in Panama's history. It built the Panama Canal, which was completed in 1914. Many U.S. civilians and soldiers then moved to Panama to guard, operate, and maintain the canal. They lived in a special area bordering the canal called the Panama Canal Zone. The United States took control of the canal and the zone in exchange for payments to Panama. In 1977, Panama and the United States signed a treaty that resulted in the transfer of the Canal Zone to Panama in 1979. Also as a result of the treaty, the United States transferred control of the canal to Panama on Dec. 31, 1999. For details on the canal and the Canal Zone, see **Panama Canal; Panama Canal Zone**.

Government

According to its Constitution, Panama is a republic. The Constitution grants the people such rights as freedom of speech and religion. Panamanians 18 years of age or older may vote in elections.



Steve C. Ropp, the contributor of this article, is Professor of Political Science at the University of Wyoming and the author of Panamanian Politics: From Guarded Nation to National Guard.



Chris Harris, Liaison

Panama is famous as the site of the Panama Canal, one of the world's most important waterways. Thatcher Ferry Bridge, *shown here,* crosses the canal near Panama City, the country's capital.

Facts in brief

Capital: Panama City.
Official language: Spanish.
Official name: *República de Panamá* (Republic of Panama).
Area: 29,157 mi² (75,517 km²). *Greatest distances*—east-west, 410 mi (660 km); north-south, 130 mi (209 km). *Coastline*—Atlantic Ocean, 397 mi (639 km); Pacific Ocean, 746 mi (1,201 km).
Elevation: *Highest*—Volcán Barú, 11,401 ft (3,475 m) above sea level. *Lowest*—sea level along the coasts.
Population: *Estimated 2002 population*—2,938,000; density, 101 per mi² (39 per km²); distribution, 56 percent urban, 44 percent rural. *1990 census*—2,329,329.
Chief products: *Agriculture*—bananas, rice, sugar cane, beef cattle, milk, coffee, corn, chickens and eggs, beans. *Manufacturing*—beverages, cement, petroleum products, processed foods. *Fishing*—shrimp, anchovetta.
National anthem: "Himno Nacional de la República de Panamá" ("National Hymn of the Republic of Panama").
Money: *Basic unit*—balboa. One hundred centésimos equal one balboa.

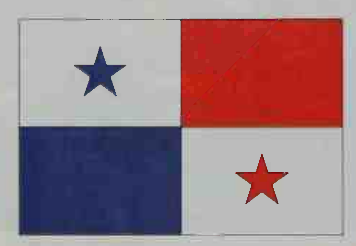
National government of Panama is headed by a president. The president is elected to a five-year term by the people. A Cabinet assists the president in carrying out the day-to-day operations of the government. The National Assembly makes the country's laws. The people elect the members of the National Assembly to five-year terms.

Local government. Panama is divided into nine provinces for the purposes of local government. The provinces are subdivided into municipal districts. The president appoints a governor to head each province. The people elect mayors and councils to govern Panama's districts. Local government officials in Panama have little policymaking authority. In general, these officials simply carry out policies made by the national government.

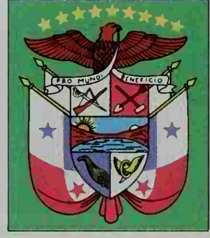
Politics. Panama has a number of political parties. The major parties include the Arnulfista Party, the Democratic Revolutionary Party, and the Papa Egoro Party.

Courts. The Supreme Court is Panama's highest court. It hears appeals from lower courts. It has nine members, who are appointed by the president to 10-year terms. Panama's lower courts include superior, circuit, and municipal courts.

Armed forces. Panama has no regular armed forces. Security is provided by the Public Forces. These civilian forces are the National Police, the National Air Service, and the National Maritime Service. Together they have about 12,000 members. Service is voluntary.



Panama's flag was adopted in 1903. Its blue star stands for honesty and purity. The flag's red star symbolizes authority and law.



The country's coat of arms bears Latin words meaning *For the Benefit of the World.* This motto refers to the role of the Panama Canal.



WORLD BOOK map

Panama occupies a narrow strip of land between the Pacific Ocean and the Caribbean Sea, a part of the Atlantic Ocean.



Michele and Tom Grimm

Cuna Indian children dance and play musical instruments during a celebration in their village. They live on one of the San Blas Islands off the northern coast of Panama's mainland.

People

Population and ancestry. A little more than half of Panama's people live in urban areas, and the rest live in rural areas. Panama's largest cities are—in order of population—Panama City, San Miguelito, and Colón. Together, these three cities have about three-fourths of the nation's urban population.

Panama has a mixed population. American Indians were its first inhabitants. In the 1500's, Spaniards became the first whites to reach Panama. They brought black slaves from Africa to Panama. In the 1800's, many blacks of African descent who were living in the West Indies settled in Panama.

Through the years, Indians, whites, and blacks intermarried. Today, about two-thirds of Panama's people are descendants of more than one group. The largest mixed groups are mestizos and mulattoes. Together, they make up about 70 percent of the population. Blacks and whites each make up from 10 to 15 percent, and Indians about 6 percent.

Way of life. The part of Panama near the Panama Canal is a busy center of urban activity. In contrast, most of the rest of the country is made up of quiet rural areas of farms, tiny villages, and small towns.

Panama City lies at the Pacific end of the Panama Canal, and Colón is at the Atlantic end. These cities are active centers of commerce, trade, and transportation. They have many modern, high-rise office buildings, and hotels, nightclubs, bars, and gambling establishments. The cities' main streets are crowded with foreign traders, sailors, and tourists, as well as Panamanians. The Panama Canal and the 10-mile (16-kilometer)-wide area that was formerly the Panama Canal Zone lie between Panama City and Colón. Through the years, people from the United States, called Zonians, established communities that resemble United States towns and suburbs in this area. The communities include Balboa and Cristóbal.

Most of Panama's white people live in the area near

the Panama Canal. Many of the whites are extremely wealthy. A small group of Panama's people, most of them wealthy whites, are called the *elite*. Their families have had wealth for several generations. The elite take great pride in their traditions, and they tend to avoid social contact with other Panamanians. This group includes bankers, industrialists, large commercial farmers, and important doctors and lawyers.

Many other whites and also many mestizos and mulattoes of the Panama Canal area belong to the middle class. They include merchants, government officials, and office workers. Most of Panama's black people live near the canal. Large numbers of the blacks are poor laborers. As in many other countries, the blacks suffer from discrimination in job opportunities.

Most Panamanians who live away from the Panama Canal area are farmers. Mestizos and mulattoes form the majority of the country's farm population. They make their homes in small villages or on farm fields, primarily in western Panama. Many of the country's farmers struggle to produce enough food for their own use.

Most of Panama's Indians live in rural areas. The main Indian groups are the Chocó, Cuna, and Guaymí. Cuna Indians who live on the San Blas Islands off Panama's northern coast are sometimes called San Blas Indians. Panama's Indians farm and fish for a living.

Traditionally, Panamanian women have had little opportunity for higher education or careers. They have been expected to marry early, raise large families, and manage their household. But since the mid-1900's, more and more women have taken jobs outside the home.

Housing. Wealthy Panamanians live in large houses built in either the Spanish colonial or a modern architectural style, or in large luxury apartments. Most middle-class people have smaller houses or apartments. Panama's poor urban people live in shacks or run-down apartments. Most rural people live in small one- or two-room houses. Many houses near the Pacific coast have



Panama map index

Provinces*

Province	Population	Map key	
Bocas del Toro	73,302	A	2
Chiriquí	345,749	B	2
Coclé	159,105	B	4
Colón	187,705	A	4
Darién	36,072	B	6
Herrera	98,206	C	4
Los Santos	80,635	C	4
Panamá	956,782	B	5
Veraguas	203,907	C	3

Cities and towns

City or town	Population	Map key	
Aguadulce	11,087	B	4
Almirante	7,047	A	2
Antón	5,987	B	4
Arraiján	16,272	B	5
Atalaya*	4,456	C	3
Bajo Boquete	9,164	B	1
Balboa	1,104	B	5
Bocas del Toro	4,363	A	2
Bugaba*	14,552	B	1
Calobre	2,237	B	3
Cañazas	6,627	B	3
Capira	3,074	B	4
Changuinola	18,911	A	1
Chepo	6,385	A	5
Chitré	17,315	C	4
Colón	59,840	A	4
David	50,016	B	1
Dolega	4,648	B	1
El Valle	3,827	B	4
Gualaca	4,286	B	2
Guararé	2,761	C	4
Hato del Volcán	4,997	B	1
La Arena*	3,809	C	4
La Chorrera	21,106	B	4
La Mesa	3,474	C	3
Las Cumbres*	31,495	B	5
Las Palmas*	3,480	C	3
Las Tablas	5,235	C	4
Los Pozos	2,077	C	3
Los Santos	5,604	C	4
Monagrillo	5,699	C	4
Montijo	4,070	C	3
Natá	5,185	B	4
Ocú	6,103	C	3
Panama City	389,172	B	5
Penonomé	9,291	B	4
Pocrí	5,987	B	4
Portobelo	2,774	A	5
Puerto Armuelles	37,123	B	1
Puerto Pilón	8,460	A	4
Río de Jesús	3,644	C	3
San Miguelito	156,611	B	5
Santa María	2,077	C	3
Santiago	32,427	C	3
Soná	7,700	C	3
Tolé	5,043	B	2

*Does not appear on the map; key shows general location.

Physical features

Feature	Map key	
Chagres River	A	5
Coiba Island	C	2
Colón Island	A	2
Darién Mountains	B	7
Gatun Lake	A	4
Mosquitos Gulf	B	3
Panama Canal	B	4
Rey Island	B	5
San Blas Islands	A	6
San Blas Mountains	A	6
Tabasará Mountains	B	3
Tuira River	C	7
Volcán Barú (volcano)	B	1

Sources: 1985 official estimates for provinces; 1980 census for cities and towns.



Chris Harris, Liaison

A street scene in Colón shows people of various ethnic backgrounds. Most Panamanians are of mixed Indian and white, or black and white, descent.



Yoram Kahana from the Marilyn Gartman Agency

Traditional costumes are worn by many Panamanians on special occasions. The woman above wears a colorful *pollera* while dancing at a fiesta. The man's shirt is called a *camisilla.*

thatched roofs, and walls made from sugar cane stalks. Many houses near the Atlantic coast are made of wood.

Clothing. Most Panamanians wear Western-style clothing most of the time. On holidays and other special occasions, large numbers of people dress in special costumes. Women may wear a *pollera,* a white garment consisting of a blouse and long full skirt that are decorated with lace and embroidery. Or, they may wear a costume of a white blouse and brightly colored skirt called a *montuna.* Men may wear a *montuno,* which consists of a white embroidered shirt and short trousers. A *camisilla* (long, white shirt) and long trousers is another special costume worn by men.

Many Panamanian farmers wear straw hats while working. These hats, which are made in Panama, are sometimes mistakenly called *Panama hats.* But Panama hats are made in Ecuador, and are not worn by many Panamanians. They received the name Panama hats during the 1800's, when Panama became a center for the shipment of the hats to other countries.

Panama's Indians, especially women of the San Blas group, are famous for their colorful costumes. San Blas women wear brightly colored garments that have elaborate embroideries. They also wear a ring that hangs from the nose and large metal disks for earrings.

Food and drink. Rice is the basic food of most Panamanians. Many of the people cook rice with beans to make a dish called *guacho. Tortillas* (flat breads made from corn or wheat flour) are a favorite food. Coffee and beer are popular beverages among Panamanians.

Recreation. Music is a favorite form of recreation in Panama. Most Panamanians enjoy musical performances, and many play instruments for recreation. Celebrations called *fiestas* are held on holidays. Fiestas feature religious rituals, dancing, music, and special meals. Baseball is the most popular sport in Panama, and basketball is also popular. Panamanians learned about these sports from U.S. citizens who moved to the country after the canal opened. Soccer is also popular.

Languages. Spanish, Panama's official language, is spoken by nearly all the people. Some Indian groups use their own local language in addition to Spanish. Many Panamanians can speak English.

Religion. About 85 percent of Panama's people are Roman Catholics. Most of the rest of the people are Protestants. The Catholic Church plays an important role in Panama. Church services and celebrations are both religious and social events for many of the people.

Education. Most of Panama's adults can read and write. For the country's literacy rate, see **Literacy** (table: Literacy rates). Panamanian law requires children to attend school from the ages of 6 to 15, or until they complete the sixth grade. But about half the children leave school before completing the requirement. Most are from poor families and leave school to begin work. About half the students who complete the sixth grade also complete high school. Panama has two universities, both in Panama City. They are the University of Panama and the University of Santa María la Antigua.

Land and climate

Panama covers the Isthmus of Panama, which has an area of 29,762 square miles (77,082 square kilometers). The isthmus extends about 410 miles (660 kilometers)



John J. Lopinot, Black Star

Housing in Panama's cities varies widely. In this scene in Panama City, old, shabby shacks stand near large, modern apartment buildings.

from west to east. From north to south, it measures only about 130 miles (209 kilometers) at its widest point and 30 miles (48 kilometers) at its narrowest point.

The Panama Canal cuts through the center of the country, dividing the land into eastern and western sections. Approximately 98 percent of the people live near the canal or in the part of the country west of it. Swamps and jungles cover much of Panama east of the canal. Only about 2 percent of the people, chiefly Indians, live in the east.

Many wild animals live in Panama. They include jaguars, ocelots, pumas, monkeys, and parrots and other tropical birds. Pine trees are abundant in Panama's mountains. Banana plants and cacao trees are grown in many parts of the country.

Panama has three land regions—the Central Highland and coastal lowlands called the Atlantic Lowland and the Pacific Lowland.

The Central Highland is a mountainous region. The Tabasará Mountains extend eastward from the Costa Rican border. The country's highest peak, 11,401-foot (3,475-meter) Volcán Barú rises near the border. The mountain range decreases in height as it extends eastward. It is made up of low hills near the Panama Canal. Panama's land rises to mountains again east of the canal. The San Blas Mountains and Darién Mountains, the main ranges in the eastern part of the country, reach heights of about 6,000 feet (1,800 meters). Valleys between the mountains in western Panama provide much good farmland.

The coastal lowlands are narrow areas that lie along Panama's Pacific and Atlantic coasts. The Pacific Lowland has much fertile farmland, which is located chiefly in the west. The Atlantic Lowland is less fertile.

Coastline and islands. Panama's Pacific coastline measures 746 miles (1,201 kilometers). The Atlantic coastline is 397 miles (639 kilometers) long. About 800 islands that lie near the coasts are part of Panama's territory. The largest ones are Coiba Island and Rey Island, both off the Pacific coast.

Rivers and lakes. Panama has about 500 rivers. But only one river, the Tuira, is navigable for long distances. The Tuira flows for 125 miles (201 kilometers) in eastern Panama. Panama has no large natural lakes. Its largest lake is the 163-square-mile (422-square-kilometer) Gatun Lake, which was created by the builders of the Panama Canal and forms part of the canal route.



WORLD BOOK photo by Terry K. McClellan

The Central Highland, shown here, is a region that covers much of Panama inland from the Atlantic and Pacific coasts. The areas near the coasts are flatter than the rugged highland.

Climate. Most of Panama has a warm, tropical climate that varies little from season to season. Temperatures in the lowlands average about 80° F. (27° C). Mountain temperatures average about 66° F. (19° C). The Atlantic side of Panama receives about 150 inches (381 centimeters) of rain annually. About 68 inches (173 centimeters) of rain falls in the Pacific side yearly.

Economy

Economic activity in Panama varies according to location. Near the Panama Canal, the economy is based on business generated by the waterway, and on commerce, trade, manufacturing, and transportation. In most of the rest of Panama, the economy is based on agriculture. The economy of Panama operates as a free enterprise system.

The Panama Canal is the most important single factor in the country's economy. Tolls from ships that pass through the canal contribute millions of dollars annually to the Panamanian economy. The Panama Canal also directly and indirectly provides jobs for many Panamanians. The jobs include positions related to the operation and maintenance of the canal. They also include jobs in stores and other businesses that exist because of the economic activity generated by the canal.

Commerce and trade flourish near the Panama Canal. Colón and Panama City rank among Latin America's chief banking centers. Colón has a Free Trade Zone, where merchants can import and export goods without paying *duties* (taxes). Many merchants send goods to Colón and then export them to other nations to save money. More than 300 import and export companies operate in the Free Trade Zone.

Manufacturing. About two-thirds of Panama's manufacturing firms are located in Panamá Province, just west of the canal. The country has few large manufacturing industries. Its chief products include beer, cement, and cigarettes. Panama has many plants that process food, including fish, fruit, milk, and sugar. An oil refinery located near Colón processes crude oil from other countries into petroleum products.

Agriculture employs about a fourth of Panama's workers—more people than does any other single economic activity. Most of these workers farm a small plot of land and use old-fashioned agricultural equipment and methods. The majority of the farmers produce only *subsistence crops*—that is, crops raised by farmers for their own use. Rice is the main subsistence crop, followed by corn and beans. Bananas rank as the chief *cash crop.* Cash crops are those that are raised for sale. Other cash crops grown in Panama include sugar cane, coffee, and tobacco. Cattle ranching is another important agricultural activity. Panamanian farmers also raise chickens and hogs.

Most Panamanians who raise subsistence crops own or rent their farms. But many of them are *squatters.* Squatters neither own nor rent the land they farm. Instead, they simply settle on land owned by the government or private citizens and farm it. Most of Panama's cash crop production takes place on large farms owned by wealthy landowners. The landowners hire agricultural workers to farm their land.

Fishing. Shrimp is the most important product of Panama's fishing industry. Anchovetta, a small fish that is ground into fish meal, ranks second. Other catches include herring and lobster.

Mining. Panama's small mining industry centers around the production of such construction materials as lime, sand, and crushed stone. Large copper deposits lie near Colón and David. However, these deposits are undeveloped.

International trade. Bananas, shrimp, and sugar are Panama's chief exports. Imports include automobiles, chemicals, machinery, and petroleum. The United States is Panama's chief trading partner. Panama also carries on much trade with Japan, Venezuela, and several Western European countries.

Transportation and communication. Panama is a major center of international transportation by sea and air. About 13,000 ships pass through the Panama Canal yearly. Cristóbal, a suburb of Colón; and Balboa, a suburb of Panama City, are busy international ports. The main airport is at Tocumen, near Panama City.

Panama's merchant marine is the largest in the world. Shipping lines of other countries own most of the ships. These companies register the ships in Panama because Panama allows them to pay lower taxes and wages than do their own countries, and also in order to avoid some safety regulations.

Only about a third of Panama's road system is paved. Most rural roads in Panama have a dirt surface. The country's major road is the Panamanian section of the Pan American Highway. It runs from the Costa Rican border to the eastern part of the country. Another important road in Panama is Trans-Isthmian Highway between Colón and Panama City.

Panama has six daily newspapers. The country has an average of about 1 radio for every 5 people and about 1 television set for every 7 people.

History

Early days. Indians were the first inhabitants of what is now Panama. Few early records of the Indians exist, and scholars have not determined when the Indians first settled in the region. The Indians farmed, fished, and hunted.



Yoram Kahana, Peter Arnold, Inc.

A farmer and his son carry home sugar cane and coconuts they have gathered. Agriculture employs more Panamanians than does any other activity. Most farming is on a small scale.

The Spanish colonial period. Spain took control of what is now Panama from the Indians during the early 1500's. In 1501, Rodrigo de Bastidas, a Spanish explorer, became the first white person to reach the area. In 1502—during his fourth voyage to the New World—Christopher Columbus, an Italian navigator employed by Spain, landed in what is now Panama. He claimed the area for Spain. A group of Spanish soldiers and colonists reached Panama in 1510. The Spaniards established colonies along the Atlantic coast. The Indians told the Spaniards of a large body of water that lay across the Isthmus of Panama, not far away. The body of water was actually the Pacific Ocean. Vasco Núñez de Balboa, acting governor of the colonies, led an expedition across the isthmus. On Sept. 25, 1513, he became the first white person to see the eastern shore of the Pacific.

The fact that Panama was only a narrow strip of land between the Atlantic and Pacific made the area important to the Spaniards. Sailing from military bases they established along the Panamanian Pacific coast, the Spaniards explored the west coast of Latin America. They conquered many of the Indian lands they reached. The most important conquest took place in the 1530's, when Spaniards led by Francisco Pizarro defeated the Inca of Peru. They took gold and other riches from the Inca and from other Indians. Spain built a stone road across Panama to transport the riches from the Pacific to the Atlantic coast. The riches then were shipped to Spain.

The Spaniards did little to develop Panama's economy. They treated the Indians harshly and killed many of them. Under Spanish rule, Panama became a center for the distribution of black African slaves in the New World.

In the 1600's, Henry Morgan of England and other pirates attacked Spanish ships and towns in Panama. Many Spanish ships carrying goods from Peru began sailing around the tip of South America to avoid the pirates. Panama declined as a transportation center.

Colombian rule. Colombia gained independence from Spain in 1819. In 1821, Panama broke away from Spanish rule and became a province of Colombia.

A gold rush began in California in 1848. People from the Eastern United States began sailing to Panama, crossing the isthmus to the Pacific, and then sailing on to California to reach the gold rush area.

Businessmen from the United States built a railroad across Panama to speed up passage across the isthmus. The railroad was completed in 1855, and Panama again became a busy transportation center.

Many laborers from other lands moved to Panama to help build the railroad. They included thousands of blacks from the West Indies. Many of the black laborers settled permanently in Panama.

Relations between Panama and the rest of Colombia were always strained, and, beginning in 1830, Panamanians staged several revolts against Colombia. In 1903, Colombia refused an offer by the United States to build a canal across Panama. Panama, encouraged by the United States, then revolted against Colombia. It became an independent nation on Nov. 3, 1903. The United States hoped to gain approval to build the canal from the newly independent country. It sent ships and troops to protect the new government against an overthrow by

Colombia. The United States, with Panama's approval, then began building the canal.

Progress as a nation. The Panama Canal was opened on Aug. 15, 1914. It brought prosperity to the part of Panama near the waterway. The United States established the former Panama Canal Zone there. The economies of the Canal Zone, Colón, and Panama City flourished. Many Panamanians moved to the canal area to find jobs. But the changes near the canal had little effect on other parts of Panama. Most of the country remained rural and underdeveloped.

Political rivalries brought instability to Panama's government during the early and mid-1900's. The government changed hands many times.

Relations with the United States. Many Panamanians opposed United States control of the Panama Canal and Canal Zone. They demanded Panamanian control. In the 1950's and 1960's, Panamanians staged many demonstrations and some riots against the continued U.S. presence.

In 1968, Omar Torrijos Herrera, a military officer, took over the government of Panama and began to rule as a dictator. He strengthened the movement to end U.S. control of the canal and Canal Zone. In 1977, Panama and the United States signed a treaty designed to end U.S. control. The treaty resulted in the transfer of the Canal Zone to Panama in 1979. It also provided for the transfer of the canal itself to Panama in 1999.

The Noriega years. General Torrijos gave up control of Panama's government in 1978. Civilian leaders took over, but Torrijos kept much power as head of the military. Torrijos died in a plane crash in 1981. The military continued to hold much power in Panama after his death.

In 1983, General Manuel Antonio Noriega became head of the military and Panama's most powerful leader. In 1987, a former aide of Noriega accused him of fraud in the 1984 presidential election, killing a political opponent, and making large amounts of money through corruption. In 1988, two U.S. federal grand juries in Florida indicted Noriega on charges of drug trafficking and racketeering in the United States. Panamanian President Eric Arturo Delvalle dismissed Noriega from his military command, but Noriega supporters forced the president from office. The U.S. government denounced this action. It imposed extreme economic sanctions against Panama and called for Noriega's resignation.

In 1989, Panama held a presidential election. Guillermo Endara, a politician opposed to Noriega, apparently won the election. But the Panamanian government declared the election invalid. On Oct. 3, 1989, a group of Panamanian soldiers tried to overthrow Noriega, but failed. The United States provided minor aid to the rebels by blocking some key roads. In December 1989, Panamanian soldiers killed a United States marine lieutenant. Mentioning this incident and the drug trafficking charges, U.S. President George H. W. Bush ordered troops into Panama to overthrow Noriega.

In January 1990, Noriega surrendered to United States officials, and Endara was named president of Panama. A new civilian government was formed. In 1992, Noriega was convicted on charges of drug trafficking, money laundering, and racketeering.

Recent developments. In 1994, Ernesto Pérez Balladares was elected to succeed Endara as president. In 1999, Mireya Moscoso became the first woman to be elected president of Panama. Also that year, on December 31, the United States handed over control of the Panama Canal to Panama.

Today, Panama faces some major changes and challenges, mainly as a result of the transfer of the Panama Canal from U.S. to Panamanian control. Although the United States still has some influence over the protection of the canal, Panama is entirely responsible for its maintenance and for protection of the surrounding rain forests. These forests provide the water that is used in the canal locks to lift and lower ships. They are increasingly threatened by poor people looking for new places to grow their food.

Panama also faces some major challenges that are not directly related to the canal. Many Panamanians live in poverty, and rich people are consuming an increasing share of the country's wealth. The government will need to find ways of dealing with the problem of poverty and ensuring that the country's economy continues to grow.

Steve C. Ropp

Related articles in *World Book* include:

Balboa, Vasco Núñez de	Noriega, Manuel A.
Central America	Panama Canal
Chagres River	Panama Canal Zone
Colón	Panama City
Columbus, Christopher	Portobelo
Herrera, Tomás	San Blas Indians
Morgan, Sir Henry	Torrijos Herrera, Omar

Outline

I. Government
- A. National government
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III. Land and climate
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V. History

Questions

Why is Panama called the *Crossroads of the World?*
What is a *pollera?* A *montuna?* A *montuno?*
How does the Panama Canal help Panama's economy?
How does the way of life differ near the Panama Canal and away from it?
What are Panama's main crops?
How has the United States influenced life in Panama?
Why was Panama important to the Spaniards?
What is the most popular sport in Panama?
What challenges does Panama face today?
Why did U.S. troops enter Panama in December 1989?

Panama, Isthmus of. See Panama (introduction; Land and climate).



Pictorial Parade

The Panama Canal is an artificial waterway that cuts across Central America and links the Atlantic and Pacific oceans. The canal enables ships to travel between Atlantic and Pacific ports without sailing around South America, saving a distance of more than 7,800 miles (12,600 kilometers).

Panama Canal is a waterway that cuts across the Isthmus of Panama and links the Atlantic Ocean and the Pacific Ocean. It ranks as one of the greatest engineering achievements in the world. Upon its completion in 1914, the canal shortened a ship's voyage between New York City and San Francisco to less than 5,200 miles (8,370 kilometers). Previously, ships making this trip had to travel around South America—a distance of more than 13,000 miles (20,900 kilometers).

The United States built the Panama Canal at a cost of about $380 million. Thousands of laborers worked on it for about 10 years, using steam shovels and dredges to cut through jungles, hills, and swamps. They had to conquer such tropical diseases as malaria and yellow fever.

The Panama Canal extends about 51 miles (82 kilometers) from Limón Bay on the Atlantic Ocean to the Bay of Panama on the Pacific Ocean (see **Panama** [map]). A ship traveling through the canal from the Atlantic to the Pacific sails from northwest to southeast. The ship actually leaves the canal 27 miles (43 kilometers) east of where it entered.

The canal has three sets of water-filled chambers called *locks,* which raise and lower ships from one level to another. The locks were built in pairs to allow ships to pass through in both directions at the same time. Each lock has a usable length of 1,000 feet (300 meters), a width of 110 feet (34 meters), and a depth of about 70 feet (21 meters). The dimensions of the locks limit the size of ships that can use the canal. For example, commercial supertankers and the supercarriers of the U.S. Navy cannot pass through it.

A 1903 treaty between the United States and Panama gave the United States the right to build and operate the waterway. The United States also received the right to govern an area of land called the Panama Canal Zone on both sides of the canal. For many years, Panama tried to gain control of the canal and the zone. In 1977, Panama and the United States signed a new treaty. As a result of this treaty, Panama received territorial jurisdiction over the zone in 1979. The United States kept administrative control of some military installations and areas necessary to operate and defend the canal. Also as a result of the treaty, Panama took control of the operations of the canal and its associated military installations on Dec. 31, 1999. A second treaty gave the United States the right to defend the neutrality of the canal beyond that date.

A trip through the canal

Entering the canal. A ship sailing from the Atlantic Ocean enters the canal by way of Limón Bay, the harbor of the town of Cristóbal, near the city of Colón. While



WORLD BOOK map

The Panama Canal shortens sea voyages between the Atlantic and Pacific oceans. A ship sailing between New York City and San Francisco saves about 7,800 miles (12,600 kilometers) by using the canal rather than traveling around South America.

the ship is still in deep water, a canal pilot comes on board from a small boat. The pilot has complete charge of the ship during its trip through the canal. After passing through the breakwater at the entrance to the bay, the ship heads south along the channel, 7 miles (11 kilometers) long, that leads to the Gatun Locks. The shipyards, docks, and fueling stations of Cristóbal line the eastern shore of the bay.

The Gatun Locks (*guh TOON*) look like giant steps. They consist of three pairs of concrete chambers that lift ships about 85 feet (26 meters) from sea level to Gatun Lake. Small electric locomotives called *mules* run on tracks along both sides of the locks. They help to position and stabilize ships in the locks. They also pull and guide small ships through the locks. Large ships go through the locks chiefly under their own power. But locomotives help pull them, and also guide them.

As a small ship approaches the first chamber, its engines are shut off. A large ship approaching the chamber keeps its engines on. Canal workers fasten the ends of the locomotives' towing cables to the vessel. The locomotives then pull a small ship, or help pull a large ship, into the first chamber. Huge steel gates close behind the vessel. Workers open valves that allow water from Gatun Lake to flow into the chamber through openings in the bottom of the lock. During the next 8 to 15 minutes, the rising water slowly raises the ship. When the level of the water is the same as the level of the water in the second chamber, the gates in front of the ship swing outward. The locomotives pull, or help pull, the vessel into the second chamber. Again the water level is raised. This process is repeated until the third chamber raises the ship to the level of Gatun Lake.

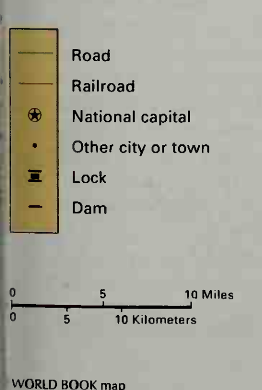
Gatun Lake. The canal workers release the cables, and the ship sails out of the locks under its own power. As it heads south across the quiet water of Gatun Lake, it passes the huge Gatun Dam to the west of the locks. This 23-million-cubic-yard (18-million-cubic-meter) earth dam is one of the largest in the world. Gatun Dam created 163-square-mile (422-square-kilometer) Gatun Lake by holding back the waters of the Chagres River. The ship steams across the lake from Gatun Locks to Gamboa, following the 22-mile (35-kilometer) channel that was once the Chagres River Valley.

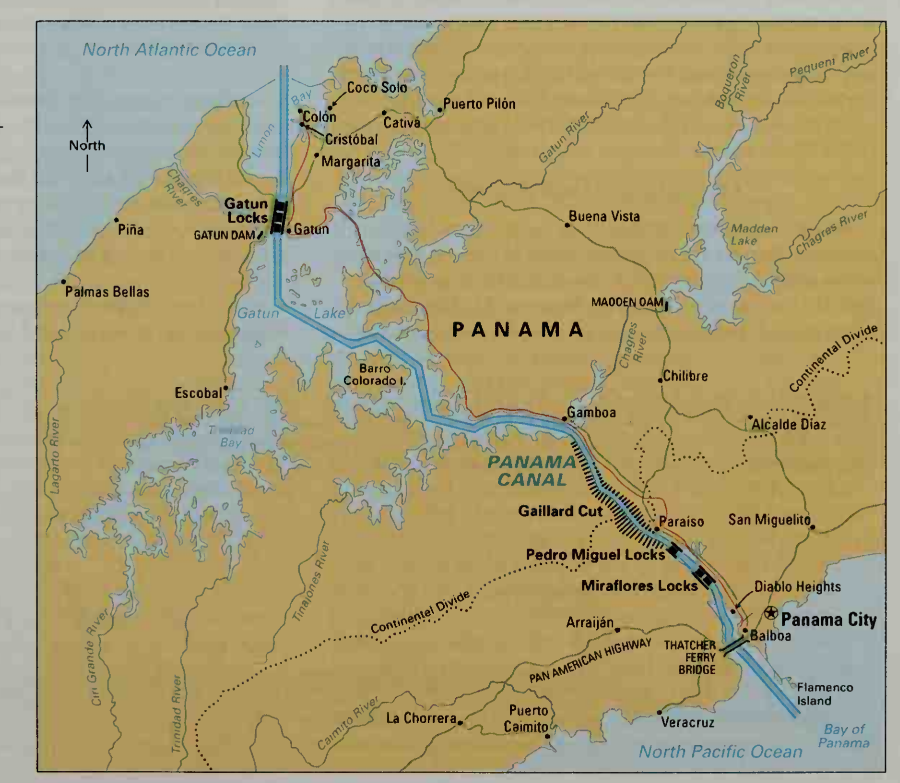
The tops of trees and hills jut above the water. They were almost submerged when engineers flooded the valley to create Gatun Lake. The violet flowers and green leaves of water hyacinths float on the lake. Their long, coarse stems can become tangled in ship propellers and endanger navigation. A special hyacinth patrol destroys more than 42 million plants a year to keep the channel clear.

The Gaillard (*gill yard*) **Cut.** When the ship reaches the southeastern end of Gatun Lake it enters the Gaillard Cut, 8 miles (13 kilometers) long and 500 feet (150 meters) wide. The cut has a minimum depth of 42 feet (13 meters). *Cut* is an engineering term for an artificially created passageway or channel. The Gaillard Cut runs between Gold Hill on the east and Contractor's Hill on the west. The Gaillard Cut was originally called the *Culebra Cut.* In 1913, it was renamed in honor of David DuBose Gaillard, the engineer in charge of digging between the hills. Dredgers work constantly to keep the channel clear of earthslides. In some years, the dredgers in the

The Panama Canal

The Panama Canal cuts through the Isthmus of Panama. It is 50.72 miles (81.63 kilometers) long. At its narrowest point, Gaillard Cut, the canal is only 500 feet (150 meters) wide. The widest part of the canal route is 163-square-mile (422-square-kilometer) Gatun Lake.





WORLD BOOK map

Gaillard Cut remove as much as 1 million cubic yards (760,000 cubic meters) of earth. For many years, the Gaillard Cut was only wide enough for one-way traffic. In 2001, engineers completed widening it to accommodate two-way traffic.

The Pedro Miguel and Miraflores locks. After the ship heads out of the Gaillard Cut, electric locomotives pull, or help pull, it into the Pedro Miguel Locks. These locks lower the vessel 31 feet (9 meters) in one step to Miraflores Lake. The ship sails 1 $\frac{1}{2}$ miles (2.4 kilometers) across the lake to the Miraflores Locks. Here, two chambers lower it to the level of the Pacific Ocean. The distances these chambers must lower the ship depend on the height of the tide in the Pacific. Tides at the Pacific end of the canal rise and fall about 12 $\frac{1}{2}$ feet (3.8 meters) a day. Tides on the Atlantic side change only about 2 feet (60 centimeters) daily.

Out of the locks, the ship heads down the channel, 8 miles (13 kilometers) long, between the Miraflores Locks and the end of the canal. It passes the towns of Balboa, Balboa Heights, and La Boca. The ship also passes under the Thatcher Ferry Bridge, an important link in the Pan American Highway. After the pilot leaves, the vessel enters the Bay of Panama and heads toward the open sea. It has traveled a little over 50 miles (80 kilometers) from the Atlantic to the Pacific in about eight hours.

Importance of the canal

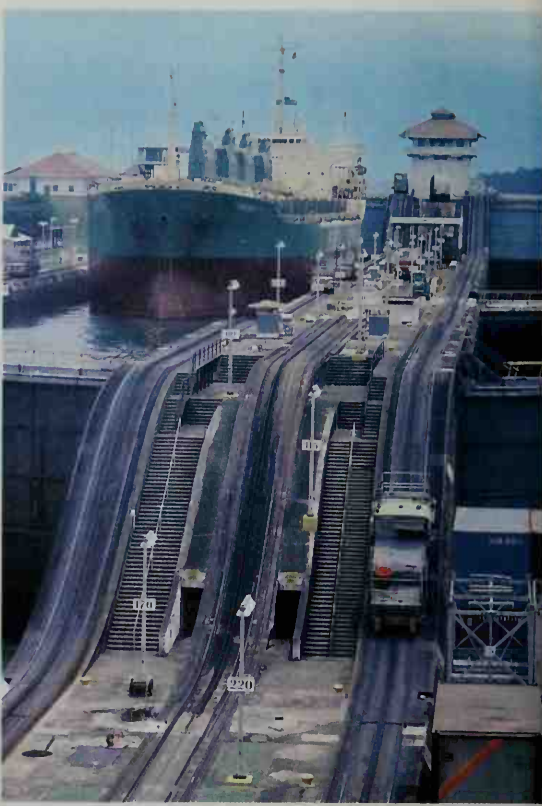
The Panama Canal is an important commercial and military waterway. About 12,000 oceangoing vessels travel through it yearly—an average of about 33 per day. The ships carry about 260 million tons (235 million metric tons) of cargo annually. About 70 percent of the cargo is being carried to or from U.S. ports. Other frequent users of the canal include Canada and Japan.

Until 1999, the United States maintained several military bases to defend the canal. Huge quantities of war materials and thousands of troops passed through the canal during World War II (1939-1945), the Korean War (1950-1953), and the Vietnam War (1957-1975).

Administration and defense

Administration. Panama took over control of the canal on Dec. 31, 1999, under terms of a treaty that had been signed by the United States and Panama in 1977. Prior to the canal's transfer to Panama, a U.S. government agency called the Panama Canal Commission operated and maintained the waterway. In addition, the commission operated public utilities and provided community, sanitation, security, and transportation services. By the time of the transfer, the Panama Canal Commission had more than 7,000 employees, about 95 percent of whom were Panamanian. The commission's board of directors consisted of five Americans and four Panamanians.

After the transfer of the canal to Panama, the Panamanian government placed it under the control of a new

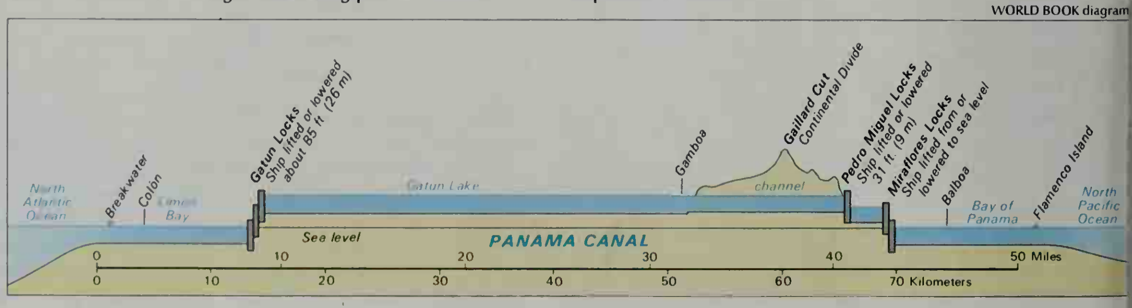


John Lopinot, Black Star

The Gatun Locks are chambers where the water level can be changed to raise or lower ships traveling through the Panama Canal. Electric locomotives, *right,* guide and help position ships in the lock chambers.

A profile of the Panama Canal shows a ship's course through the waterway. A ship from the Atlantic Ocean is lifted by the Gatun Locks to the level of Gatun Lake. The ship crosses the lake and passes through the Gaillard Cut channel. The Pedro Miguel and Miraflores locks lower it to the level of the Pacific. The raising and lowering process is reversed for a ship from the Pacific.

WORLD BOOK diagram



agency created specifically to operate and maintain the waterway. Unlike the old U.S. Panama Canal Commission, the Panama Canal Authority is controlled by a Panamanian board of directors appointed by the president of Panama and approved by the country's legislature. The authority is an extremely powerful agency with the right to manage all its own financial affairs, control its labor force, and make its own laws.

The Panama Canal Authority collects tolls from ships that use the canal. The amount of the toll paid by a merchant ship is generally determined by the ship's cargo space. The toll for certain smaller vessels is based on the length of the vessels. Military ships pay a toll based on their weight.

Defense. International law requires that commercial and military vessels of all nations be allowed to pass through the canal in peacetime. A treaty signed by the United States and Panama in 1977 guarantees that the canal will remain open to all nations even in time of war. The agreement gives the United States the right to use military force if necessary to protect the neutrality of the canal.

History

Early efforts. Hundreds of years before the Panama Canal was completed, people of many lands dreamed of building a canal across Central America. As early as 1517, Vasco Núñez de Balboa, the first European to reach the Pacific, saw the possibility of a canal connecting the Atlantic and Pacific oceans.

Throughout most of the 1800's, Nicaragua was the chief center of efforts to build a canal. Both the United States and the United Kingdom considered a canal across Nicaragua. During the 1840's, the two nations almost went to war because of disputes over which one would control the proposed canal. In 1850, in the Clayton-Bulwer Treaty, they agreed to protect the neutrality of a canal to be built somewhere across the Central American isthmus. See **Clayton-Bulwer Treaty**.

During that period, present-day Panama was a province of Colombia. Colombia feared that the United Kingdom would try to seize Panama for use as a canal site. Colombia signed a treaty with the United States in 1846. The United States agreed to guard all trade routes across Panama and to preserve Panama's neutrality.

The Panama Railroad. During the California gold rush that began in 1849, the Isthmus of Panama became an important route between the Eastern United States and California. Many prospectors sailed from Atlantic Coast ports to Panama, crossed the isthmus by boat, on mules, and on foot, and then took another ship for California. In 1850, Colombia permitted a group of business executives from New York City to build a railroad across the isthmus. The line was completed in 1855 at a cost of $8 million. It linked Colón on the Atlantic side and Panama City on the Pacific side.

The French failure. In 1878, Colombia granted a French adventurer named Lucien Napoleon Bonaparte Wyse the right to build a canal across Panama. He sold the right to a French company headed by Ferdinand Marie De Lesseps, who had directed the construction of the Suez Canal. The French also bought control of the Panama Railroad for $20 million. The company began digging in 1882. The French planned a canal that would run at sea level between the Atlantic and Pacific, and so would need no locks. In 1886, the problems of building a sea-level canal forced the French to decide to build a canal similar to the present one. De Lesseps and his assistants planned most of the project carefully and carried out some of it efficiently. However, the French wasted great quantities of material and effort. A group of dishonest politicians who supported De Lesseps stole large amounts of money from the canal company. The French engineers lacked the proper tools to complete such a huge digging job. In addition, scientists did not know how to fight the epidemics of tropical diseases that hit the workers.

De Lesseps's company went bankrupt in 1889, after digging out some 76 million cubic yards (58 million cubic meters) of earth. A second French firm, the New Panama Canal Company, took over the property and franchise in 1894. But the new company made only half-hearted efforts to continue digging, in order to keep the franchise until a buyer could be found.

The United States and the canal. A group of United States business executives began working on a canal across Nicaragua in 1889. But the group ran out of money soon after beginning the Nicaraguan project. Both the American and French groups tried to sell their rights and property to the United States government. However, American railroad executives opposed construction of any Central American canal because they feared competition from shipping lines that would use the canal. As a result, the United States government took no action on either project.

During the Spanish-American War in 1898, the United States Navy sent the battleship *Oregon* from San Francisco to Cuba to reinforce the Atlantic Fleet. The *Oregon* had to sail nearly 13,000 miles (20,900 kilometers) around the tip of South America. The trip would have been only about 4,600 miles (7,400 kilometers) long through a canal. This fact helped convince the United States Congress that a canal across Central America was essential for national defense.

In 1899, Congress authorized a commission to survey possible canal routes. The commission favored Nicaragua, because a canal there would require less digging than one across Panama. But the French company offered to sell its Panama rights and property and the Panama Railroad for $40 million. Philippe Bunau-Varilla, of the French company, convinced leading Americans that Nicaragua's volcanoes presented the danger of earthquakes and that Panama was safer. In 1902, Congress gave President Theodore Roosevelt permission to accept the French offer if Colombia would give the United States permanent use of a canal zone. Congress acted after the United States and the United Kingdom had replaced the Clayton-Bulwer Treaty with the Hay-Pauncefote Treaty. This treaty gave the United States sole right to build and operate a canal across Central America. See **Hay-Pauncefote Treaty**.

In 1903, U.S. Secretary of State John Hay signed a canal treaty with a Colombian representative, Tomás Herrán. The treaty provided that the United States would give Colombia an initial payment of $10 million and pay $250,000 annual rent for the use of the zone. But the Colombian legislature refused to approve the treaty because it felt that this was not enough money.



President Theodore Roosevelt visited the construction site of the Panama Canal in 1906. He wrote his son about the Gaillard Cut, saying, "They are eating steadily into the mountain . . . ."

A group of Panamanians feared that Panama would lose the commercial benefits of a canal across the isthmus. The French company worried about losing the sale of its property to the United States. The Panamanians, with the help of the French and some encouragement from the United States, revolted against Colombia on Nov. 3, 1903, and declared Panama independent. In accordance with its 1846 treaty with Colombia, the United States sent ships to Panama to protect the Panama Railroad. Marines landed in Colón, and prevented Colombian troops from marching to Panama City, the center of the revolution. On Nov. 6, 1903, the United States recognized the Republic of Panama. Less than two weeks later, Panama and the United States signed the Hay-Bunau-Varilla Treaty. It gave the United States permanent, exclusive use and control of a canal zone 10 miles (16 kilometers) wide. In return, the United States gave Panama an initial payment of $10 million, plus $250,000 a year, beginning in 1913. The United States also guaranteed Panama's independence. The United States took over the French property in May 1904.

Victory over disease. The greatest obstacle to building the Panama Canal was disease. The Isthmus of Panama was one of the most disease-ridden areas in the world. In 1904, Colonel William C. Gorgas took charge of improving sanitary conditions in the Canal Zone. Gorgas, an American physician, had become famous for wiping out yellow fever in Havana, Cuba, after the Spanish-American War.

Gorgas began a campaign to destroy the types of mosquitoes that carried malaria and yellow fever. The first two years of canal building were devoted largely to clearing brush, draining swamps, and cutting out large areas of grass where the mosquitoes swarmed.

By 1906, Gorgas had wiped out yellow fever and eliminated the rats that carried bubonic plague in the Canal Zone. By 1913, he had also reduced the rate of deaths caused by malaria.

Cutting through the isthmus. Roosevelt appointed a civilian commission to lead the canal project. In 1906, Congress decided to build a canal with locks, rather than the sea-level canal that the French had originally planned. Engineers believed a canal with locks would be cheaper and faster to build. They also felt a canal with locks would control the Chagres River's floodwaters better than a sea-level canal would. The work progressed slowly, chiefly because of disagreements among the commission members. In 1907, Roosevelt put Colonel George W. Goethals, an Army engineer, in charge of the project and the Canal Zone.

The construction task involved three major engineering jobs. The builders had to excavate the Gaillard Cut, build a dam across the Chagres River to create Gatun Lake, and build the canal's locks. The biggest job was digging the Gaillard Cut. The hills through which the cut runs consist of a soft volcanic material, and digging into them was like digging into a pile of grain. As soon as workers dug a hole, more rock and earth would slide into the space, or push up from below. The engineers had expected to remove about 95 million cubic yards (73 million cubic meters) of earth and rock to build the canal. They actually dug out about 211 million cubic yards (161 million cubic meters). Some of this was used later in the construction of Gatun Dam.

At the height of the work in 1913, more than 43,400 people worked on the Panama Canal. Three-fourths were blacks from the British West Indies. Other workers came from Italy and Spain. Most of the clerical and skilled workers came from the United States.

The oceans united. The main work of building the Panama Canal was completed in 1914. On August 15, 1914, a passenger-cargo ship owned by the Panama Railroad Company, the S.S. *Ancon,* made the first complete trip through the canal. The ship sailed from the Atlantic to the Pacific and made a reality of the canal slogan—"The Land Divided, the World United." A giant landslide in the Gaillard Cut closed the canal for several months in 1915 and 1916. It was the last major interruption in the operation of the Panama Canal. President Woodrow Wilson proclaimed the official opening of the Panama Canal on July 12, 1920.

The canal cost the United States about $380 million. This included the $40 million paid to the French company, the $10 million paid to Panama, and $20 million for sanitation. The remaining $310 million was spent for the actual construction work.

The canal since 1920. The Madden Dam, completed in 1935, was the first major improvement on the canal. The dam lies across the Chagres River, east of the canal. It created 22-square-mile (57-square-kilometer) Madden Lake, which stores water for use in Gatun Lake. The dam also holds back the floodwaters of the Chagres River during the rainy season.

In 1936, the United States agreed to raise its annual payments to Panama to $430,000, which made up for a devaluation of the dollar. In 1955, the payments were increased to about $2 million a year.

During the 1950's, engineers began to widen the Gaillard Cut from 300 to 500 feet (91 to 150 meters). This project was completed in 1970.

From the 1920's to the 1970's, the United States and Panama had many disputes concerning U.S. control over the Panama Canal Zone. The Panamanians regarded the zone as part of their country. They believed the 1903 treaty, which established the zone, was unfairly favorable to the United States. Some Panamanians also resented the large number of U.S. military bases in the zone. See **Panama Canal Zone**.

In 1971, Panama and the United States began negotiations for a new treaty to replace the 1903 pact. In 1977, the two nations signed two new treaties. One of the treaties provided for the transfer of territorial jurisdiction over the Panama Canal Zone to Panama in 1979. This treaty also provided for Panama to take control of canal operations in 1999. The other agreement gave the United States the right to defend the neutrality of the canal beyond 1999.

Many Americans opposed giving up control of the canal and the zone, which they regarded as United States property. Other Americans favored the treaties. They believed continued United States control would harm relations with Latin American nations. The two agreements were approved by Panama's voters in 1977 and by the U.S. Senate in 1978. The treaties took effect in 1979.

Panama formally took control of the canal on Dec. 31, 1999. Former President Jimmy Carter represented the United States at ceremonies held earlier that month to mark the transfer of the canal. Carter had played a leading role in negotiating the canal treaties. Steve C. Ropp

Related articles in *World Book* include:

Canal
Chagres River
Clayton-Bulwer Treaty
De Lesseps, Ferdinand M.
Goethals, George W.
Gorgas, William C.
Hay-Pauncefote Treaty
Panama
Panama Canal Zone
Roosevelt, Theodore (Foreign policy)

Outline

I. A trip through the canal
II. Importance of the canal
III. Administration and defense
IV. History

Questions

What limits the size of ships that can use the Panama Canal?
Why is the Panama Canal important?
Who operates the Panama Canal?
What were the three major engineering jobs necessary to dig the canal?
What was the greatest obstacle to building the canal?
How did the Spanish-American War affect the canal?
How long does it take a ship to pass through the Panama Canal?
How was Gatun Lake formed?
What was the first major improvement on the Panama Canal?

Additional resources

Mann, Elizabeth. *The Panama Canal.* Mikaya, 1998. Younger readers.
McNeese, Tim. *The Panama Canal.* Lucent Bks., 1997.
Parker, Nancy W. *Locks, Crocs, and Skeeters: The Story of the Panama Canal.* Greenwillow, 1996. Younger readers.

Panama Canal Zone was a strip of land across the Isthmus of Panama that was governed by the United States from 1903 to 1979. The Panama Canal, a waterway that connects the Atlantic Ocean and the Pacific Ocean, cuts through the center of the zone. The zone came under Panama's control as a result of a treaty with the United States that went into effect in 1979.

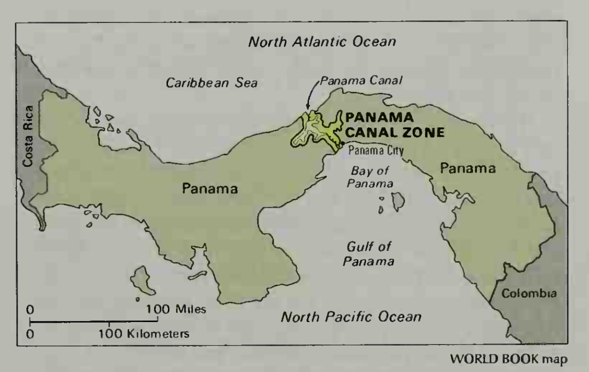
The Panama Canal Zone was established in 1903 by a treaty between the United States and Panama. The pact gave the United States permanent control of a zone of land 10 miles (16 kilometers) wide and about 40 miles (64 kilometers) long. This grant was made for the construction and operation of the proposed Panama Canal, which the United States completed in 1914. The area designated by the treaty excluded what are now Panama City and Colón.

Later agreements between Panama and the United States added Madden Lake and Trinidad Bay to the area under U.S. control. Before Panama took control, the zone covered 647 square miles (1,676 square kilometers), including 275 square miles (712 square kilometers) of water. The zone had a population of about 40,000, of whom about 36,000 were U.S. citizens. Most of the people worked for the U.S. Army, the Canal Zone government, or the Panama Canal Company, a U.S. government corporation that operated the canal. The U.S. citizens were called *Zonians.*

The United States and Panama had many disputes over U.S. control of the Panama Canal Zone. The Panamanians considered the zone part of their country. Crowds of Panamanians rioted in 1958 and 1959, demanding the right to fly their country's flag in the zone. In 1962, Panama and the United States agreed to fly the flags of both countries side by side in selected civilian areas of the zone. The United States also granted higher wages to Panamanians in the zone. Previously, Panamanians were paid less than Americans were for the same work.

Riots broke out again in 1964, and 20 Panamanians and 4 Americans were killed. Panama then cut off diplomatic relations with the United States. Relations between the two nations were restored after the United States agreed to negotiate a new treaty to replace the 1903 pact. During the following years, three treaties were drafted. However, neither government approved any of those pacts.

During the 1970's, the two nations again held negotiations for a new treaty. In 1977, they signed two new treaties. One provided for Panama to assume territorial jurisdiction over the zone in 1979. It also provided for Panama to assume control over the operations of the canal and its associated military installations on Dec. 31, 1999. The other treaty gave the United States the right to



WORLD BOOK map

Location of the Panama Canal Zone

defend the canal's neutrality. The agreements were approved by Panama's voters in 1977 and by the United States Senate in 1978. Both treaties went into effect in 1979. Steve C. Ropp

See also **Panama Canal**.

Panama City (pop. 389,172) is the capital and largest city of Panama. It lies at the Pacific Ocean end of the Panama Canal and is a crossroads of world trade. For location, see **Panama** (map).

Panama City consists of widely different sections. A historic section occupies a peninsula on the Pacific coast. This section contains narrow streets and buildings that date to the late 1600's. Spaniards built this section to replace the original Spanish settlement, which was destroyed by pirates. Ruins of the original settlement lie about 5 miles (8 kilometers) east of the peninsula. Several treelined boulevards cross downtown Panama City. This area contains a broad promenade along the seafront. Interesting downtown buildings include the Palace of Justice, the Presidential Palace, and the Museum of the Panamanian Man. The nearby ATLAPA (Atlantic and Pacific) Convention Center, which can hold 16,000 people for exhibitions, overlooks the ocean.

The city's wealthy people, who include descendants of immigrants from many countries, live in tall, modern buildings or in magnificent residences surrounded by tropical gardens. Most of these homes are located on the outskirts of the city and in the suburbs. Many poor Panamanians live in sprawling slums in the city.

Most workers hold jobs in government or international trade, or with the Panama Canal. Panama City is an important banking center, and more than 100 foreign banks have branches there. Tourism also is a chief source of income. The city's industries include food processing and the manufacture of clothing. The Pan American Highway links the city with other parts of Central America, and with Mexico and the United States.

Panama City was founded in 1519 by Pedro Arias de Ávila, a Spanish adventurer. In 1671, the English pirate Henry Morgan led 1,400 men against Panama City and destroyed it. But the city was rebuilt in 1673. The Panama Canal opened in 1914. It made the city a center for world trade (see **Panama Canal**). Nathan A. Haverstock

See also **Panama** (picture).

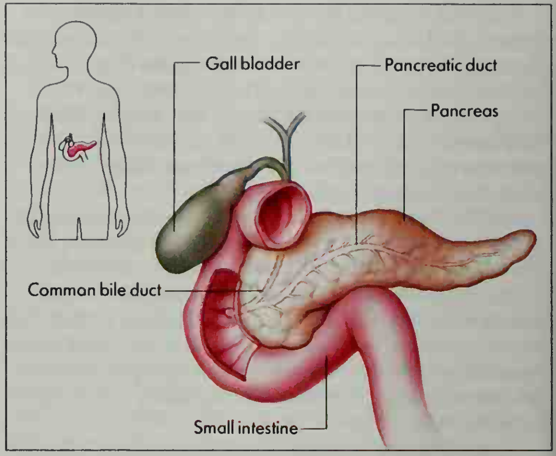
Panama hat. See **Ecuador** (picture); **Panama** (Clothing).

Pancake Tuesday. See **Shrove Tuesday**.

Pancreas, *PAN kree uhs,* is a body organ found in human beings and all animals with backbones. It produces digestive juices required to break down foodstuffs. It also produces *insulin* and *glucagon,* two hormones needed to regulate the body's sugar balance and *metabolism* (see **Metabolism**).

The human pancreas is a pinkish-yellow gland about 6 to 8 inches (15 to 20 centimeters) long, 1 $\frac{1}{2}$ inches (3.8 centimeters) wide, and 1 inch (2.5 centimeters) thick. It lies crosswise, behind the stomach. The first part of the small intestine, the *duodenum,* loops around the pancreas. Digestive juices secreted by the pancreas flow through a duct into the duodenum. The secretion contains water and salts that aid the digestive process and neutralize stomach acids. Enzymes in the secretion help to break down proteins, starches, and fats.

Small clusters of special cells called the *islets* (or *islands*) *of Langerhans* are scattered throughout the pancreas. The cells secrete hormones directly into the bloodstream. There are several types of islet cells, including *alpha cells* and *beta cells.* Insulin is produced by beta cells. Insulin travels through the bloodstream to cells throughout the body. It enables cells to take in and use glucose from the blood. Glucose, a sugar, is the main fuel of the body's cells. If the pancreas secretes too little insulin, a serious form of the disease diabetes mellitus results (see **Diabetes**).



WORLD BOOK illustration by Robert Demarest

The pancreas produces digestive juice, which flows through the pancreatic duct into the small intestine. It also secretes the hormones insulin and glucagon into the bloodstream.

The alpha cells secrete glucagon. Glucagon causes the liver to release stored glucose into the bloodstream. Glucagon and insulin work together to regulate the level of glucose in the blood. Charles Liebow

Related articles in *World Book.* See the Trans-Vision three-dimensional picture with **Human body**. See also:

Diabetes	Insulin
Digestive system	Pancreatitis

Pancreatitis, *PAN kree uh TY tihs,* is a disease that involves inflammation of the pancreas. People who have pancreatitis experience attacks of sudden, severe pain in the abdomen. Attacks usually occur after large meals and may become chronic. Chronic pancreatitis can lead to diabetes, inability to digest food, or cancer of the pancreas. Acute attacks often result in death.

Pancreatitis primarily affects the portion of the pancreas that produces digestive enzymes. Normally, these enzymes flow through a duct into the small intestine, where they break down food. In people with pancreatitis, however, the inflamed pancreas releases enzymes into its own tissue instead of into the duct. The enzymes break down the tissue of the pancreas and can continue to do so until the entire organ is destroyed.

Heavy or prolonged drinking of alcoholic beverages increases the risk of developing pancreatitis. People who smoke cigarettes and those who have gallstones also are at special risk. Some cases of pancreatitis have been associated with hereditary factors.

Treatment of acute pancreatitis requires hospitalization. People with chronic pancreatitis should eat low-fat foods and avoid drinking alcohol. Charles Liebow

Panda is the name of two species of Asian mammals that differ greatly in appearance. The *giant panda* is a large, black-and-white animal. The *red panda,* also called the *lesser panda,* is reddish-brown and much smaller. Both species live in bamboo forests on upper mountain slopes of western and southwestern China. The red panda also lives in Nepal, northern India, and northern Myanmar. Giant pandas are rare and are protected by law in China.

Zoologists disagree about how closely the giant panda and the red panda are related to each other. They also disagree on whether to classify pandas in the raccoon family, in the bear family, or in a family of their own. Red pandas have many characteristics in common with raccoons. These include fur markings and the ability to grasp objects with the front paws. Giant pandas resemble bears in size, body shape, general appearance, and the ability to stand erect on their hind legs. In addition, molecular studies indicate that DNA (deoxyribonucleic acid) of red pandas resembles that of raccoons, and the DNA of giant pandas more closely resembles that of bears. Many zoologists studying pandas in the wild, however, argue that the two species of pandas should be placed in a family of their own.



Flip Schulke, Black Star

The giant panda commonly weighs from 200 to 300 pounds (90 to 140 kilograms). It often eats sitting upright with its hind legs stretched out. The smaller red panda weighs only from 6 to 12 pounds (2.7 to 5.4 kilograms).

Tierbilder Okapia



Pandas eat bamboo. The giant panda eats bamboo shoots, as well as bamboo stems and leaves. The red panda eats bamboo leaves. Pandas grasp the bamboo between their fingers and an "extra thumb." This thumb, which is a bone covered by a fleshy pad, grows from the wrist of each forepaw. Pandas also have true thumbs, which they use as fingers.

Unlike most plant-eating animals, pandas have inefficient digestive systems that cannot easily change plant food into energy. As a result, pandas must eat large quantities of bamboo to get enough energy. For example, giant pandas eat as much as 85 pounds (39 kilograms) of bamboo shoots per day.

The giant panda has a white, chubby body with black legs and a broad band of black across the shoulders. It has a large, round head; small, black ears; and a white face with black patches around each eye. This panda commonly grows to about 5 to 6 feet (1.5 to 1.8 meters) long and has a short tail. Adults weigh about 200 to 300 pounds (90 to 140 kilograms).

The female giant panda gives birth once a year to one or two cubs. Panda cubs are extremely tiny, weighing only about 5 ounces (140 grams) at birth. The mother, who normally spends about 12 hours per day feeding, stays with the newborn cub for up to 10 days without feeding. Cubs normally nurse for about a year and may remain with the mother for more than two years.

The red panda has long, soft fur, and a bushy tail with rings like that of a raccoon. This panda weighs about 11 pounds (5 kilograms) and grows to about 2 feet (61 centimeters) long, not including the tail. It has a pale face with a rusty-red streak that curves downward from each eye. The red panda climbs easily and sleeps in a tree most of the day. It searches for food at dawn and dusk. Red pandas are more likely than giant pandas to eat foods other than bamboo, such as fruits and berries.

Protecting pandas. Widespread cutting of forests for wood and farmland in China has destroyed a large part of the habitat of pandas. The Chinese government has tried to protect pandas by establishing reserves of bamboo-rich public land for them. Fairly large reserves are needed because every 15 to 120 years, bamboo plants flower and produce seeds, then die. It takes several years for the seeds to grow into plants that can provide food for pandas. Since the late 1970's, such periodic die-offs of bamboo have led to the deaths of hundreds of giant pandas from starvation. Scientists estimate that fewer than 1,000 giant pandas remain in the wild. The number of red pandas remaining is unknown.

Other efforts to ensure the survival of giant pandas have focused on breeding them in zoos. However, most breeding attempts have failed. In 1972, China gave two giant pandas to the United States. These two pandas—Ling-Ling, a female; and Hsing-Hsing, a male—were placed in the National Zoological Park in Washington, D.C. Before Ling-Ling died in 1992, she gave birth to cubs several times, but each cub died shortly after birth. Hsing-Hsing died in 1999. Researchers continue to study pandas in an effort to find better ways to breed the animals in zoos and to protect them in the wild.

Gregory K. Snyder

Scientific classification. The scientific name for the giant panda is *Ailuropoda melanoleuca.* The red panda is *Ailurus fulgens.*

Pandit, Vijaya Lakshmi, *PUHN diht, vih JY uh LAHK shmee* (1900-1990), one of India's most famous women, became known for her work in government and for her interest in the women's movement. Madame Pandit was appointed ambassador to the Soviet Union in 1947, and ambassador to the United States in 1949. From 1953 to 1954, she served as the first woman president of the United Nations General Assembly. She then became Indian high commissioner in the United Kingdom. Madame Pandit became ambassador to Ireland in 1955 and ambassador to Spain in 1958. She held both posts until 1961. Madame Pandit served as governor of the Indian state of Maharashtra from 1962 to 1964. She served in India's Parliament from 1964 to 1967 and retired from public life in 1968.

Madame Pandit was born in Allahabad. Like her father and brother, Motilal and Jawaharlal Nehru, she took a prominent part in India's struggle for independence and was jailed several times. Her brother served as India's prime minister from 1947 to 1964. Indira P. Gandhi—her niece and Jawaharlal's daughter—became prime minister of India in 1966. In 1977, Madame Pandit campaigned against her niece's political party because she opposed the way it had restricted freedom in India.

Robert LaPorte, Jr.

See also **Nehru; Gandhi, Indira.**

Pandora, *pan DAWR uh,* in Greek mythology, was the first woman. Zeus, the king of the gods, ordered Pandora created as a punishment for men. Zeus was angry because men had received fire stolen from the gods by Prometheus (see **Prometheus**). Zeus ordered Hephaestus, the blacksmith of the gods, to create Pandora. The gods and goddesses then adorned her with many gifts to make her alluring. The name *Pandora* means *all gifts* in Greek.

Zeus gave Pandora to Prometheus' brother Epimetheus. In spite of Prometheus' warnings, Epimetheus gave her to men. Pandora's curiosity led her to open a jar, and all types of evil, including disease and hard labor, escaped to plague humanity. Only Hope did not escape from the jar. Ancient Greek sources are vague about the origin of the jar.

Many writers have noted the resemblance between Pandora and Eve in the Bible. In 1508, the Dutch author Desiderius Erasmus first used the image "Pandora's box" instead of the traditional jar or vase. Pandora's box has come to symbolize any object or situation that has a great potential for evil. Justin M. Glenn

Pangolin, *pang GOH luhn,* is the name of several species of animals that resemble anteaters and armadillos. Pangolins live in southeastern Asia, Indonesia, and parts of Africa south of the Sahara. Like anteaters, pangolins are toothless and have long, narrow snouts, long tails, and sticky, ropelike tongues that they can thrust far out to catch the ants on which they feed. Pangolins have coats of mail formed by overlapping horny scales, instead of the coarse hair of anteaters. These scales are various shades of brown.

Pangolins vary in length from 3 to 5 feet (0.9 to 1.5 meters), depending on the species. The *long-tailed pangolin* of western Africa lives in trees. Its tail is about two-thirds of its total length. All pangolins have large, strong claws on their forefeet, which they use to rip open the nests of ants and termites.

Pangolins can roll themselves into tight balls so heavily armored that few enemies can harm them. They are inoffensive animals, but when captured they may lash out with their scaled tails.

Pangolins are much hunted for their excellent meat. But because they are shy and look for food only at night, they have been saved from extinction.

Scientific classification. Pangolins make up the family Manidae. Asian pangolins make up the genus *Manis.* African pangolins make up the genus *Phataginus.* The scientific name for the long-tailed pangolin is *Phataginus tetradactyla.*

Bruce A. Brewer

See also **Anteater.**

Panic disorder is a mental illness characterized by sudden, unexpected attacks of intense fear or terror. The attacks are accompanied by symptoms of bodily illness. People commonly experience panic when facing danger. In people with panic disorder, however, attacks of panic occur without obvious reason.

Most panic attacks last several minutes. The person may fear that he or she is losing control of thoughts and actions and may experience an overwhelming fear of death. Physical symptoms include shortness of breath, dizziness, trembling, sweating, a choking sensation, nausea, numbness or a tingling sensation, hot flashes, and chest pain. Generally, doctors make a diagnosis of panic disorder only if a person has had four or more panic attacks within a four-week period. However, one





Clem Haagner, Ardea, London

Pangolins live in southeastern Asia, Indonesia, and parts of Africa. The animal has a coat of horny scales. It rolls itself into a ball, *right,* for protection against attackers.

attack is sufficient for a diagnosis if it results in long-lasting, severe fear of having another attack.

People with panic disorder become very depressed and some become so depressed they commit suicide. Some patients develop *agoraphobia* (the fear of open spaces) and may stay inside their homes for years. The symptoms of a panic attack may mimic other serious disorders, especially heart attack.

The cause of panic disorder is not known for certain. Studies suggest that genetic factors are responsible. The disorder usually first strikes before age 30.

Doctors treat panic disorder with medications used to treat anxiety and depression. Psychotherapy and behavior therapy are also effective treatments.

Steven C. Dilsaver

Panic of 1837. See **Van Buren, Martin** (The panic of 1837); **Wildcat bank.**

Panic of 1873. See **Grant, Ulysses S.** (The panic of 1873); **Black Friday.**

Pankhurst, Emmeline Goulden (1858-1928), led the fight for women's voting rights in Britain. With her husband, Richard M. Pankhurst, she helped form the Women's Franchise League in 1889. In 1903, she helped organize the National Women's Social and Political Union, with the slogan "Votes for Women." In their bold program, Mrs. Pankhurst's followers differed from older "suffragettes." They staged parades and engaged in such violence as window-breaking to gain attention. She and her followers, including her daughters Christabel and Sylvia, suffered rough handling and imprisonment. During World War I (1914-1918), they turned to patriotic work. Women received equal voting privileges in Britain the year of Mrs. Pankhurst's death. She was born in Manchester, England. Louis Filler

Panmunjom, *pahn moon jahm,* is the site of the truce talks that ended the Korean War in 1953. It lies in a neutral area, called the *Demilitarized Zone,* between North Korea and South Korea (see **Korea** [political map]). Before the truce talks, Panmunjom was a small civilian village. Today, it is the point of contact between North and South Korea, and between United States and North Korean military representatives. The Panmunjom area is guarded by North Korean forces on the north side, and South Korean and U.S. troops on the south side.

The Korean War truce talks took place between the United Nations Command—represented by the United States—on one side, and North Korea and China on the other side. The talks began in July 1951 in Kaesong, a city under North Korean control. In October, the talks were moved to Panmunjom, situated in neutral territory. The talks led to the signing of a truce agreement on July 27, 1953. Chong-Sik Lee

Panoptes. See **Argus.**

Pansy is a commonly cultivated type of violet. The beautiful flowers may be purple, violet, blue, yellow, white, brown, deep red, or a mixture of these colors. The pansy is a low-growing plant that grows best in a moist location with some shade. Most garden varieties live only a year. Some varieties are *perennials*—that is, they live at least three years. The word *pansy* comes from the French word *pensée,* which means *thought.*

The pansy is also called the *heartsease, ladies-delight,* and *stepmother's flower.* The *European wild pansy,* which is also known as the *field pansy* or *Johnny-jump-up,* is a perennial with much smaller flowers.

Scientific classification. The pansy belongs to the violet family, Violaceae. James S. Miller

See also **Flower** (picture: Garden annuals).

Pantheism, *PAN thee ihz uhm,* is the belief that the essence of God is in all things. It is often associated with nature religions, including many American Indian, African, and ancient Middle Eastern religions. In these religions, gods are connected with such things as storms, stars, the sky, the sea, fertility, and skill in hunting. In the Japanese Shinto tradition, gods are identified with natural objects, including rocks and trees. In a more general sense, pantheism refers to any religious philosophy that identifies God with nature. Mark Juergensmeyer

See also **God; Polytheism.**

Pantheon, *PAN thee ahn,* is a well-preserved ancient temple in the center of Rome. It was completed under the rule of the Roman emperor Hadrian about A.D. 126. Hadrian dedicated the temple to all the Roman gods. Its name comes from the Greek word *pantheion,* which means *place for all gods.* The temple served as a Christian church from 609 until 1885. It then became a national shrine and the burial place for Italian national heroes. Famous Italians buried there include King Victor Emmanuel I and the Renaissance painter Raphael.

The Pantheon was constructed largely of brick and concrete. It is a circular building that measures about 142 feet (43 meters) in diameter. It has a dome roof that rises about 142 feet (43 meters) above the floor at its highest point. A rectangular *portico* (porch) extends from the entrance of the building. The portico has a triangular roof that is supported by a row of eight Corinthian columns. Many of the engineering techniques used to build the Pantheon are still used today.

The Pantheon was one of the first buildings to emphasize interior space rather than exterior form. The interior is beautifully and evenly lit by an *oculus* (opening) that measures 30 feet (9 meters) in diameter at the top of the dome. The proportions of the central space have been highly praised for their harmony. The bronze doors at the entrance and some of the marble used in the interior decoration are part of the original construction of the Pantheon. William J. Hennessey

See also **Architecture** (Roman architecture; picture).

Panther is a name used loosely for certain members of the cat family. It is given to the *leopard,* which is a native of Asia and Africa. The *puma* of North America, also known as the *cougar* or *mountain lion,* is sometimes called a panther, particularly in the Eastern United States. A few authorities apply the name only to large leopards. See also **Florida panther; Leopard; Mountain lion.** Duane A. Schlitter

Pantograph, *PAN tuh graf,* is the name of a mechanical drawing instrument which copies, traces, or cuts in duplicate a design, map outline, or drawing. It is made of four bars or rods held together by adjustable pins. One end of the pantograph is held stationary. One tracing point is moved over the design to be copied, following its outlines. Another point will then move in unison with this point, copying or cutting a duplicate outline. The pantograph can be set, by using adjustable pins, to copy in any size. Todd I. Blue

Pantomime refers to acting without words. It comes from the Greek words meaning *all mimic.* All actors



Shostal

Pantomime is the art of acting with gestures, using no words. The French pantomimist Marcel Marceau, shown here, became famous for his ability to act out entire stories by himself.

today use a certain amount of pantomime. Many plays have silent passages in which only the movements of an actor's arms, legs, or face express ideas. In fact, all expressive movement of the body could be considered pantomime. Ballet and opera also use some pantomime.

Pantomime began in ancient Rome. It had a single dancer who was supported by musicians and a chorus. The chorus narrated short versions of well-known Greek or Roman heroic tales, while the dancer used masks and costumes to act out various characters.

During the 1700's, pantomime plays were popular in England and France. They owed much to a popular type of Italian comedy, *commedia dell'arte,* and its stock characters. Early English pantomimes always used a servant clown called Harlequin, a lovable father called Pantaloon, and a lively daughter called Columbine. In the early 1800's, English pantomimes added a new stock character called Clown. These shows combined music and songs, dancing and acrobatic acts, and had elaborate scenery and stage effects.

During the mid-1800's, George L. Fox, an American pantomimist, was popular as Humpty-Dumpty. Fox used stage productions of fairy tales or nursery stories. Today, Christmas entertainment in the United Kingdom includes similar pantomimes. Don B. Wilmeth

See also **Dance** (Asian theatrical dance); **Marceau, Marcel.**

Pap test is a procedure for detecting cancer cells and abnormalities that could become cancerous in the female genital tract. It is most commonly used to evaluate the condition of the *cervix,* which includes the bottom portion and the opening of the uterus. The test is also called the *Papanicolaou test* and *Pap smear test.* George Papanicolaou, a Greek-born physician, developed the procedure in the United States from the 1920's to the 1940's. Wide-spread use of the Pap test has helped to greatly reduce the death rate from cancer of the cervix.

Before cancer develops in the cervix, the cells of the cervix go through many precancerous changes. These changes typically take several years. If a woman has Pap smear screenings regularly, precancerous abnormalities and early stages of cancer can be detected while these problems can be easily treated. With regular follow-up examinations, the woman can usually avoid developing *invasive cancer* (cancer that grows deeply into tissues).

A Pap smear can be performed in a physician's office. The procedure causes no pain and little discomfort. The physician collects a sample of cells from the cervix with a cotton swab, wooden scraper, or small brush. The physician then places the sample on a glass slide and sends it to a medical laboratory for examination. If abnormal cells are detected, the physician may examine the cervix through a type of microscope called a *colposcope* (pronounced *KAHL puh skohp*). If the physician finds abnormalities, a *biopsy* (removal and examination of tissue) will be performed to reach a diagnosis.

Women 18 years of age or older should have Pap smears taken annually. If a girl has sexual intercourse before the age of 18, she should begin having Pap smears earlier. Women who have had an abnormal Pap smear may need to be tested more frequently than once a year. Vicki Seltzer

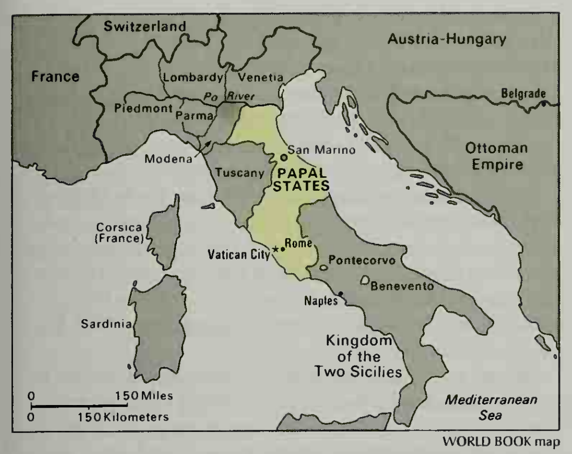
Papacy. See Pope.

Papal States was the name given to territory once ruled by the pope of the Roman Catholic Church. The pope exercised *temporal* (economic, military, and political) control over the Papal States. Most of the states were located in central Italy, with some lands in France for a time. Today, the pope has temporal control only over the 109 acres (44 hectares) of Vatican City, an independent country within the boundaries of Rome.

The Papal States originated in 756 with land that Pepin the Short, king of the Franks, gave to Pope Stephen II. The Papal States began to grow during the reign of Saint Leo IX in the mid-1000's. The states expanded the most in the 1200's, particularly under the leadership of Pope Innocent III. The Papal States declined in political and economic strength during the 1600's and 1700's.

In 1809, Emperor Napoleon I of France annexed the Papal States and made Pope Pius VII a prisoner. After Napoleon's defeat, the Congress of Vienna restored most of the states to the pope in 1815. However, the return was temporary. Residents of the Papal States revolted against papal control in 1831, in 1848 and 1849, and again in 1860. During the revolt of 1860, Victor Emmanuel II conquered central Italy, and in 1861 he declared the formation of the Kingdom of Italy. Victor Emmanuel became its first king. Only the land immediately surrounding Rome remained under the control of the church. The establishment of the Kingdom of Italy began a period of political and religious conflict between the popes and the Italian government known as the Roman Question.

In 1870, French forces stationed in Rome withdrew, and Victor Emmanuel captured the city. He asked Roman citizens whether the city should become the political capital of a united Italy. The people voted for unification, thus effectively ending the Papal States as a distinct church-controlled territory. Pope Pius IX shut himself up in the Vatican in protest and referred to himself as a prisoner.



WORLD BOOK map

The Papal States before 1870 were large and important tracts of land in the heart of Italy. Today, the Holy See has temporal power only over Vatican City in Rome.

The Roman Question was finally resolved in 1929. In that year, an independent Vatican City state was established through an agreement called the Lateran Treaty. The treaty was made between Pope Pius XI and the Italian government. Under its terms, all financial claims between the two sides were settled, with Italy presenting a payment of cash and bonds to the church. The papacy, in effect, gave up its claims to the territory of the Papal States. Vatican City was to be fully independent. The church was to have exclusive jurisdiction within its boundaries, and the territory was always to be considered neutral and inviolable. In a separate *concordat* (agreement) signed at the same time, the Italian government accepted both the church's status as the official state religion and the church's jurisdiction in Italy over such matters as marriage and divorce.

In 1984, the Italian government and the Vatican ratified a revised version of the concordat. The revised version retained the independence of Vatican City but ended other church privileges, including the church's status as the state-supported religion in Italy. Ronald Burke

See also **Italy** (History); **Vatican City; Rome** (History); **Pepin the Short.**

Papaw. See **Papaya; Pawpaw.**

Papaya, *puh PY uh,* is a nutritious tropical fruit that has edible flesh and seeds. People usually eat the fruits fresh for breakfast, for dessert, or as an ingredient in salads.

Papaya flesh is a rich source of vitamins A and C, as well as potassium and calcium. In addition, green immature papayas yield papain, a substance used to aid digestion. Ripe papayas have little or no papain. People obtain this substance by drying the sticky, white milk that the fruits release when their skin is scratched.

Papayas vary in shape, with many appearing round or oval. Most grow between 5 and 6 inches (13 and 15 centimeters) long and weigh about 1 pound (0.5 kilogram). The fruit's smooth skin generally has greenish-yellow to orange coloring when ripe. Its flesh varies from 1 to 2 inches (2.5 to 5 centimeters) thick and ranges from light yellow to deep salmon pink in color. A mass of round, black, wrinkled seeds cling to inner walls of the flesh.

Papayas grow on slender, hollow-stemmed plants that may reach a height of 25 feet (8 meters) or more. The



WORLD BOOK illustration by Kate Lloyd-Jones, Linden Artists Ltd.

Papaya is a tropical fruit that grows on a slender, hollow-stemmed plant. Papayas have a mild, sweet flavor and are rich in nutrients. People commonly eat them for breakfast or dessert.

plants grow best in fertile, well-drained soil. They develop quickly from seeds and begin to bear fruit 9 to 12 months after planting.

The papaya is native to tropical regions of North and South America. But people grow the fruit commercially in many warm areas around the world. Brazil, Chile, Indonesia, India, and Mexico rank as the world's leading producers. In the United States, growers cultivate papayas in Hawaii and Florida.

In New Zealand and some other English-speaking countries, papayas are also called *pawpaws.* However, papayas are not the same as the pawpaw fruit of the southern United States (see **Pawpaw**). Michael J. Tanabe

Scientific classification. The papaya belongs to the papaya family, Caricaceae. Its scientific name is *Carica papaya.*

Papeete. See **Society Islands; Tahiti.**

Papen, *PAH puhn,* **Franz von** (1879-1969), was a German politician who helped make Adolf Hitler head of the German government in 1933. Papen persuaded Paul von Hindenburg, Germany's president, to appoint Hitler *chancellor* (prime minister). Papen did not belong to Hitler's Nazi Party, which had become Germany's largest political force by 1933. Papen, who had been forced to resign as chancellor in 1932, wanted to use the Nazis to stabilize Germany's government. But he hoped that he and his fellow conservatives would keep the real power. However, Hitler quickly made himself dictator.

Papen was born to an aristocratic family on Oct. 29, 1879, in Werl, near Dortmund. He gained political power through friendship with Hindenburg. When Hitler took power, Papen became vice chancellor. Papen served as Germany's special minister and ambassador to Austria from 1934 to 1938 and as its ambassador to Turkey from 1939 to 1944. In Turkey, he organized Nazi spy operations during World War II (1939-1945). In 1946, Papen was found innocent of war crimes at trials held in Nuremberg, Germany, by the nations that defeated Germany in the war. But German courts imprisoned him until 1949. William Sheridan Allen

Paper is one of our most important industrial products. Books, magazines, and newspapers are printed on paper. Data obtained from computers are often printed on paper. Education, government, and industry could not operate without printing and writing papers. Other important paper products include paperboard, which is used in packaging, and absorbent papers, such as tissue and toweling.

World production of paper and paperboard totals more than 350 million tons (315 million metric tons) each year. The United States is the leading paper-producing country. Mills in the United States make about 30 percent of the world's paper and paperboard.

Paper is made from cellulose fibers, which are found in all plant cell walls. When a mixture of water and fibers is filtered through a fine screen, the fibers tangle together to form a sheet of paper. As the wet sheet is dried, chemical bonds form between the molecules in cellulose fibers next to one another, giving the sheet of paper its strength. Papermaking fibers come from many different plant sources, including bamboo, cotton, esparto, hemp, jute, sugar cane, wheat and rice straws, and various woods. Wood is the major source of papermaking fibers in North America.

Paper manufacturers produce thousands of grades and types of paper. The properties of any paper depend on the fibers and processes used in making it.

How paper is made

Raw materials. For centuries, the principal raw materials used in papermaking were cotton and linen fibers obtained from rags. Today, these fibers have been largely replaced by wood *pulp.* Pulp is the name used for fibers that have been prepared for papermaking. Wood used for papermaking is either harvested for this purpose or comes from lumber and woodworking wastes. Some cotton and linen fibers are still used for high-quality writing papers, business letterhead papers, art papers, and documents that will be kept for years.

Wood pulps are obtained from many kinds of wood, including aspen, beech, birch, fir, gum, hemlock, oak, pine, and spruce. The fibers used for papermaking were once living cells in the wood of the tree trunk. Fibers are thin, hollow tubes sealed at the ends, and are from $\frac{1}{25}$ to $\frac{1}{5}$ inch (1 to 5 millimeters) long. A substance called *lignin* holds the fibers together.

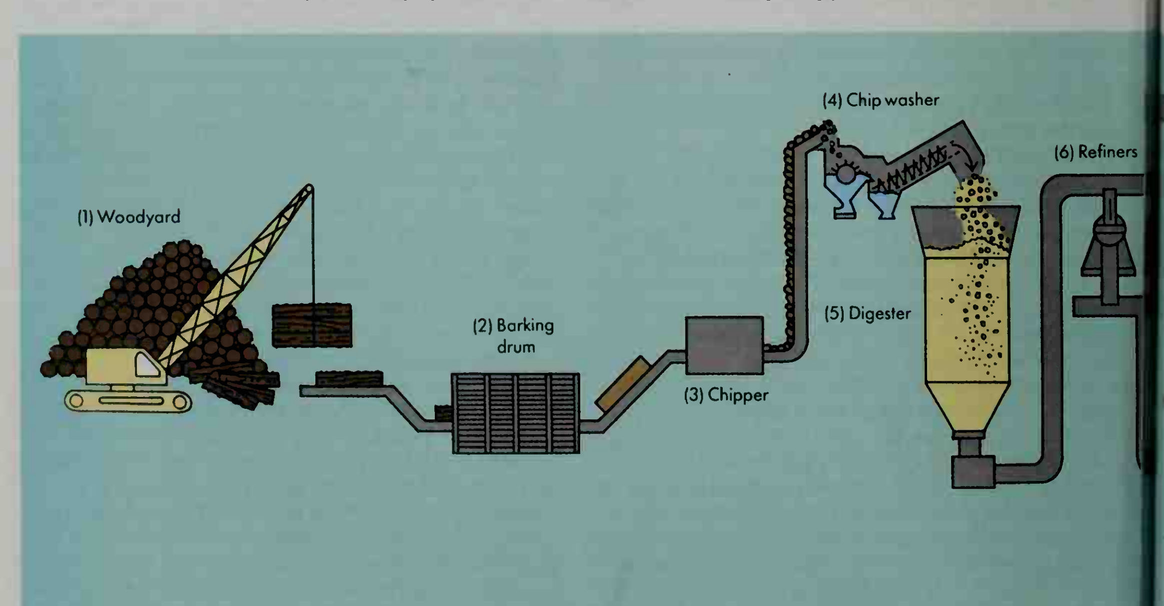
Waste paper is sometimes recycled to make new paper. Large tanks called *pulpers* convert newspapers, magazines, and other printed wastes into usable pulp. Ink is removed through use of solvents and other chemicals, detergents, and special cleaning methods. Recycled fiber is sometimes called *secondary fiber.* Manufacturers use secondary fiber to make paperboard, some printed papers, paper napkins, and toweling.

Pulping processes. There are three different kinds of pulping processes used to convert wood into pulp. They are (1) mechanical processes, (2) chemical processes, and (3) semichemical processes. Semichemical processes combine chemical and mechanical methods.

The oldest mechanical process is the *stone groundwood process,* in which short logs are forced against a specially prepared grindstone. Friction heats the wood and causes the lignin between the fibers to soften. The grindstone then can easily grind fibers from the wood's

How paper is made from wood

This diagram illustrates the steps involved in making paper from wood. It shows the semichemical method of making wood pulp. The pulping process begins with logs from the *woodyard.* The logs are fed into a revolving *barking drum,* which removes the bark. Then they are cut into chips in a *chipper.* The chips are washed in a *chip washer* and treated in huge tanks called *digesters.* In a machine called a *refiner,* rotating disks break the pulp down into individual fibers. The refined pulp passes into *pulp washers* where chemicals from the digesting process are rinsed off.



surface. In *thermo-mechanical pulping,* wood chips are preheated and fed between the rapidly rotating disks of a machine called a *refiner.* The mechanical action of the disks breaks the heated wood into individual fibers.

In chemical pulping processes, chemicals dissolve the lignin between the wood fibers. First, the wood is washed and cut into chips $\frac{1}{2}$ to 1 inch (12.5 to 25 millimeters) long. In the *sulfite chemical process,* the wood chips are cooked in an acid solution in a steam-heated pressure tank called a *digester.* In the *Kraft process,* also called the *sulfate process,* chips are cooked in a solution of caustic soda and sodium sulfide. The cooking can be done in a *batch digester* or in a large tower called a *continuous digester.*

Semichemical processes use chemicals to soften the lignin. Disk refiners then mechanically separate the fibers from one another.

Pulps produced by any of the processes are washed and then passed through a series of screens to remove knots, debris, and other foreign material. Some pulps may be bleached to produce a whiter sheet of paper.

Refining. In refining, the pulp passes between the rotating plates of a disk refiner. The mechanical action of the refiner unravels the fiber cell wall, making the fibers more flexible. The amount of refining the pulp receives determines the quality of the paper.

Sheet formation. At one time, all paper was made by hand, one sheet at a time. Today, a papermaking machine can make a continuous sheet of paper up to 33 feet (10 meters) wide, at speeds faster than 5,600 feet (1,700 meters) per minute. Some papermaking machines are more than 350 feet (110 meters) long. Among the most common machines are *Fourdrinier papermaking machines.*

In a Fourdrinier machine, a device called a *headbox* spreads a mixture of water and fibers across the *wire,* a continuously moving plastic screen. As the wire moves

Leading paper-manufacturing countries

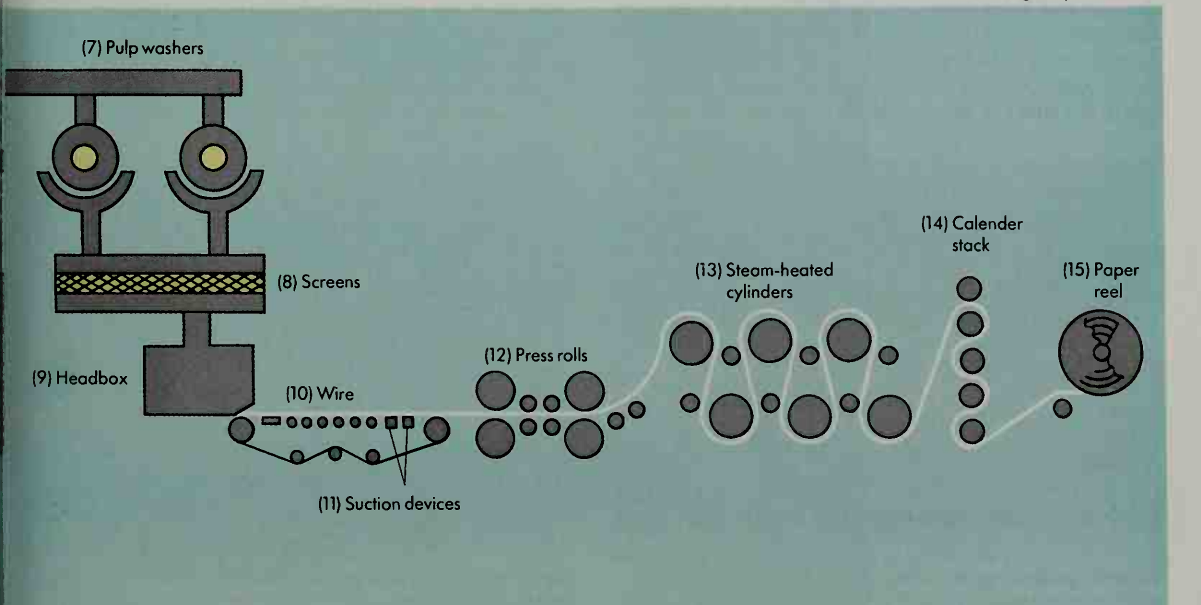
Tons of paper and paperboard produced in a year

Country	Production
United States	83,568,000 tons (75,812,000 metric tons)
China	34,814,000 tons (31,583,000 metric tons)
Japan	32,944,000 tons (29,886,000 metric tons)
Canada	23,377,000 tons (21,207,000 metric tons)
Germany	17,980,000 tons (16,311,000 metric tons)
Finland	14,003,000 tons (12,703,000 metric tons)
Sweden	10,890,000 tons (9,879,000 metric tons)
France	10,078,000 tons (9,143,000 metric tons)
Italy	9,090,000 tons (8,246,000 metric tons)
South Korea	8,542,000 tons (7,749,000 metric tons)

Figures are for 1998.
Source: Food and Agriculture Organization of the United Nations.

The pulp is then forced through screens that remove knots, debris, and other unwanted material. The formation of paper sheets begins in the *headbox,* where wet fibers are spread across a moving plastic screen called a *wire.* Water drains off, leaving a mat of fibers. The mat passes between rollers that squeeze out most of the water. Steam-heated cylinders further dry it. The dried sheet is smoothed between the cylinders of a *calender stack* and fed onto a giant roll on a *paper reel.* Finally, the large roll of paper is shipped to a manufacturing plant to be made into finished products.

WORLD BOOK diagram by Arthur Grebetz



along the Fourdrinier machine, water drains off, leaving a mat of fibers on the surface of the wire. Suction devices help to drain the water through the wire. When the mat is about one-fifth fiber and four-fifths water, the sheet has enough strength to be removed from the wire. The sheet then passes between large press rolls that squeeze water from the sheet until it is about one-half fiber and one-half water. Most of the remaining water is removed as the sheet passes over steam-heated cylinders. Chemical bonds that hold the finished sheet together form during this drying process.

The dried sheet may be smoothed by pressing it between the cylinders of a *calender stack.* It is then wound into giant rolls at the *reel,* and shipped to manufacturing plants to be made into finished products.

Twin-wire machines are similar to Fourdrinier machines, except that the sheet is formed between two moving screens. This enables the papermaker to remove water from both sides of the sheet.

A *cylinder machine* is used to make heavy paper and paperboard. A wire-covered cylinder, called a *mold,* is partially immersed and rotated in a vat of water and fibers. The sheet forms on the cylinder as water passes through the screen covering. The wet sheet is removed from the mold by a moving fabric belt called a *felt.* Several sheets of fibers can be layered on a single felt to form a multilayer paperboard. Sheets formed on cylinder machines are pressed and dried before they are wound at a reel.

Special kinds of paper

The properties of paper depend on various factors. These factors include the type of pulp used, the amount of refining done on the pulp, and the kind of papermaking machine used. Special additives, as well as treatments given to the paper during or after its manufacture, also affect the finished product.

Newsprint is usually made from thermo-mechanical pulp, or from a blend of one part chemical pulp for strength and three parts groundwood pulp, for low cost and good printing properties. Many writing and printing papers are *sized* to prevent inks from spreading into the paper. Sizing is done either by including certain chemicals in the sheet or by coating the surface of the sheet with a starch solution. Dyes that bind to the pulp fibers produce colored papers. Many magazine and book papers are coated with a mixture of starch solution and clay. The coating becomes glossy when the paper is polished between the rolls of a *super-calender.* Paper treated in this way is especially good for printing.

Inexpensive writing papers are made from mechanical pulps. Higher-quality writing papers use blends of bleached chemical pulps. Rag pulps produce the finest writing papers. Many writing and document papers are *watermarked* by pressing a wire pattern into the top surface of the wet sheet while it is still on the Fourdrinier wire (see **Watermark**).

Toweling and napkins are made from recycled fibers or from blends of sulfite and mechanical pulps. Papermakers use special additives to give these products strength when wet. Most bag papers are made from well-refined, unbleached Kraft pulps. Bleached Kraft pulps are used for food packaging. Bleached Kraft paperboard may be coated with wax or plastic for milk cartons and paper cups. Cereal boxes and other cartons, tablet backs, and posterboards are made on cylinder machines from recycled newsprint.

Other products

Pulping processes produce a number of useful byproducts. For example, used Kraft pulping chemicals can be treated to recover turpentine and *tall oil,* a raw material used in paints and plastics. Imitation vanilla extract and alcohol can be made from used sulfite cooking solutions.

Some wood pulps are made for purposes other than papermaking. For example, mechanical and sulfite pulps serve as absorbent wadding in sanitary products and diapers. Manufacturers use pure sulfite pulps as raw materials for rayon and cellophane.

History

Paper gets its name from *papyrus,* a reed that the ancient Egyptians used for making a writing material. The Egyptians cut papyrus stalks into thin strips and pressed crisscrossed layers of strips into sheets.

Paper as we know it was invented in China about 2,000 years ago. At first, the Chinese used the hemp



Wall painting from Dynasty XVIII (1570-1320 B.C.); Granger Collection

Paper in ancient Egypt was made from the fibers of a water plant called papyrus. This tomb painting shows workers harvesting and bundling papyrus.



Woodcut (1700's); Institute of Paper Chemistry, Appleton, Wisconsin

Papermaking in Japan involved mixing fibers and water, *left.* A worker scooped the mixture into a screenlike mold, *right.* The water drained away and the molded fibers dried into sheets.

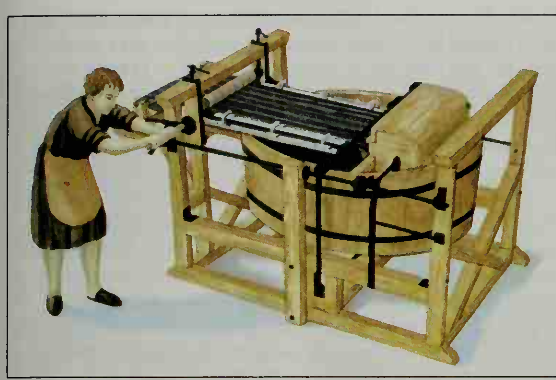


Illustration from *How Paper Is Made.* Reproduced by permission of Threshold Books Ltd.

A papermaking machine was the first device that could produce paper in a continuous roll rather than in single sheets. Nicholas Louis Robert invented the machine in 1798.

plant or the inner bark of the mulberry tree for fiber. Later, they found that good papermaking fibers could be obtained by pounding rags, rope, or fishing nets into a pulp. Early Chinese paper was too coarse for use in writing. The Chinese used it for wrapping and clothing.

The Chinese art of papermaking spread to other parts of the world after several Chinese papermakers were captured by Arabs in what is now Western Turkestan. The Arabs urged the papermakers to continue their art and teach it to the Moors in the city of Samarqand. The paper industry was established in Baghdad in A.D. 795. Papermaking spread to Europe as a result of the Crusades and the Moorish conquest of northern Africa and Spain. The first papermill in America was established near Philadelphia in 1690.

In 1798, a Frenchman named Nicholas Louis Robert invented a machine to make paper in continuous rolls rather than sheets. The Fourdrinier brothers, who were English merchants, financed improvements in this machine in 1803. The first American Fourdrinier machine was built in 1827.

The stone groundwood method for making wood pulp was developed in Germany in 1840. In 1854, the first chemically produced wood pulp was made in England. During the 1850's, the American chemist Benjamin C. Tilghman found that the fibers in wood could be separated by treating them with sulfurous acid. By 1882, much of the wood pulp used was made by this process.

In 1883, a German inventor named Carl Dahl discovered that adding sodium sulfate to the soda process produced a very strong pulp. This discovery produced the Kraft process. *Kraft* means *strength* in German. During the early 1900's, the Kraft process became the most important pulping process, and the Fourdrinier machine became the primary device for making paper.

Significant improvements in papermaking in recent years include thermo-mechanical pulping, synthetic wires and felts, twin-wire machines, and the use of computers to control pulping and papermaking operations. Paper manufacturers have also worked to improve pollution control and energy conservation in the industry.

D. Steven Keller

Related articles in *World Book* include:

Cardboard
Cellulose
Environmental pollution
Ink
Lignin
Manuscript
Paper bag
Papier-mâché
Papyrus
Parchment
Printing
Recycling
Watermark

Additional resources

Biermann, Christopher J. *Handbook of Pulping and Papermaking.* 2nd ed. Academic Pr., 1996.
Hiebert, Helen. *The Papermaker's Companion.* Storey Bks., 2000.
Turner, Silvie. *The Book of Fine Paper.* Thames & Hudson, 1999.
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Mead Paper Co.



The press section of a modern Fourdrinier papermaking machine, *center,* squeezes water from the fibrous web and chemical bonding begins. In the next step of the papermaking process, the remaining water is removed in the machine's drying section.

Paper bag is one of our most useful items. It may vary in size from a small candy wrapper to a huge shopping bag. Yet, about a hundred years ago, the paper bag was unknown. In the 1850's, manufacturers shipped most commodities such as flour and sugar to storekeepers in bulk. If the customer did not bring a container, a clerk would make a *cornucopia,* or a twist from paper. As trade developed, many merchants began pasting such containers together in advance. They turned up the end to form a "package" ready for quick use. Several machines for making paper bags were invented in the United States by the early 1860's. S. E. Pettee built the best known of these machines. He began licensing his apparatus to printers in 1865. He collected a royalty for their use. Pettee's success spurred other inventors to creative effort, but these early attempts did not create the industry. The paper bag industry was born in 1869 when the best features of all types of machinery were purchased and put together in one machine by the Union Company of Pennsylvania.

The swift success of the concerns that started paper bag manufacture caused the Union Company to go into business itself in 1875 as the Union Bag and Paper Company. In the first year it made 606 million bags. This was a fabulous number in those days, and the industry was established. The mass production greatly cut costs to retailers.

Today, manufacturers produce four main types of paper bags: The *flat bag* is a flat tube sealed at one end, such as a small candy bag. The *square bag* has tucks at the sides to give more space. A popcorn bag is an example. The *satchel-bottom bag* has a large bottom section so that it will stand upright when filled. The *automatic bag* has a rectangle-shaped bottom and tucks in the side, so it can be opened easily with a snap of the hand.

Specialty bags include bags with slick linings to prevent snagging fragile items. Others may be greaseproof, mothproof, or heat-sealed. Larry L. Graham

Paper nautilus. See **Argonaut** (mollusk).

Paperback book. See **Book** (The 1800's; Modern books); **Publishing** (Designing and printing).

Paperwork refers to the use of decorative papers. People have designed and used such papers for hundreds of years. Most decorative papers are made with paper produced by machines. But some of the finest decorative papers are made with handmade paper. The printing of decorative papers involves the use of such graphic arts processes as wood-block and linoleum-block engraving. Decorative papers can be divided into several categories, including end paper, lining paper, wallpaper, wrapping paper, and paper handicrafts.

End papers are decorative papers that printers once pasted on the inside of the front and back covers of books. The use of end papers dates back to early printed books. Most end papers were made of *marbled paper*—that is, paper printed to resemble the lined and mottled appearance of marble.

Lining papers are used to line drawers and to cover cupboards and shelves. They often have lively floral designs with a recurrent bird pattern. Lining papers may also be decorated with small, repeated landscapes.

Wallpaper is decorative paper used to cover inside walls. People have used wallpaper for hundreds of years in such countries as England, France, and the United States. During the 1700's, artists designed wallpaper with formal landscape scenes. Such paper was made only for the wealthy. It was widely used in France and England and exported to the United States. Also during the 1700's, many people used wallpaper decorated with Chinese objects and patterns, in a style called *Chinoiserie.* See **Wallpaper.**

Wrapping paper is used for wrapping gifts. Many wrapping papers have attractive and colorful patterns that make them suitable for use at holidays, birthdays, or other special occasions. The most common wrapping papers are glazed papers printed on one side only. Wrapping papers also include patterned tissue paper. In addition, people wrap gifts with such paperlike materials as metal foil and tinted cellophane.

Paper handicrafts have been popular in the United States since the 1600's. Today, people frequently make paper decorations and favors for parties and other special events. Crepe paper is widely used to make such objects as costumes, paper flowers, and holiday novelties, including Christmas tree ornaments. In the folk art called *quilling,* thin strips of paper are coiled and pinched into teardrop or eye shapes and glued together to make abstract designs and figures. Both the Chinese and the Japanese have developed traditional paper handicrafts that involve making cuts in folded pieces of paper. The cuts create elaborate patterns that appear when the paper is unfolded. The Japanese also fold uncut sheets of paper to make objects in an art form called *origami* (see **Origami**). Robert J. Lang

Papier-mâché, *PAY puhr muh SHAY,* is a mixture of paper and glue used in crafts and the fine arts. Papier-mâché is used to make such items as furniture, jewelry, masks, dolls, and toys. Artists use papier-mâché to create sculptures.

Traditional papier-mâché involves tearing paper into small pieces and adding them to white glue or wallpaper paste until the mixture becomes pasty. The mixture can be placed into a mold or built up on a frame made of wire or other material. The frame has the skeletal shape of the object being made. Papier-mâché can also be made by tearing paper into small squares and coating each piece with glue. The pieces can be pasted on cardboard, metal, wood, or other surfaces to cover and decorate objects.

After papier-mâché has dried and hardened, its surface can be smoothed with sandpaper and painted. Lace, string, and other decorations can also be added. Papier-mâché can also be coated with varnish or other substances to make it water-resistant and durable.

Papier-mâché was probably developed by the Chinese during ancient times. In the 1600's, the French became the first Europeans to use papier-mâché, creating boxes, trays, and other decorative objects. The English became noted for the beautiful furniture they made with the material during the 1800's. Dona Z. Meilach

See also **Doll** (The 1800's).

Papillon, *PAP uh lahn* or *pa pee YAWN,* is a small breed of dog. Most papillons measure from 8 to 11 inches (20 to 28 centimeters) high at the shoulder and weigh from 4 to 8 pounds (1.8 to 3.6 kilograms). The name *papillon* is French for *butterfly* and refers to the dog's ears, which resemble butterfly wings when erect. Papillons have silky white coats with patches of color.

How to make a papier-mâché doll




To begin the doll, wrap a bottle with clear plastic and then tape a layer of heavy paper to the plastic, *left.* Next, tape a cone of heavy paper to the top of the bottle, *right.*




To complete the body, paste many layers of newspaper strips to the bottle, *left.* Then cut the doll's head out of heavy paper and attach it with tape to the cone, *right.*




WORLD BOOK photos by Steinkamp/Ballogg

To decorate the doll, remove the bottle, leaving the paper shell. Then paint the doll with water colors, *left.* Finally, add a paper skirt and paste on yarn for hair, *right.*



© Callea Photo

A papillon has a white coat with patches of color.

The breed was developed in Spain in the 1500's.

Critically reviewed by the Papillon Club of America

See also **Toy dog.**

Papineau, *PAHP un noh* or *pa pee NOH,* **Louis Joseph** (1786-1871), organized a French-Canadian revolt against the government of Lower Canada in 1837. The rebellion failed, but it focused attention on the desire of French Canadians to control their own affairs.

Papineau was born in Montreal. In 1809, he won election to Lower Canada's legislature. French Canadians formed a majority in the elected assembly. But the British governor and an appointed Legislative Council controlled by English-speaking officials decided all important matters. Papineau's group, called the Patriots, tried to lessen the influence of the Council. Their inability to do so led to the rebellion in November 1837. Papineau fled to the United States to avoid arrest and later moved to Paris. He returned to Canada in 1845, when the government granted him a pardon. Papineau served in the Canadian legislature from 1848 to 1854. Fernand Ouellet

Paprika, *puh PREE kuh* or *PAP ruh kuh,* is a red seasoning. It is prepared by grinding the dried pods of a type of cultivated pepper plant called *Capsicum annuum.* Paprika is less biting than red or cayenne pepper, and it has a sweeter taste. It is also one of the richest sources of vitamin C found in a plant. See also **Pepper.**

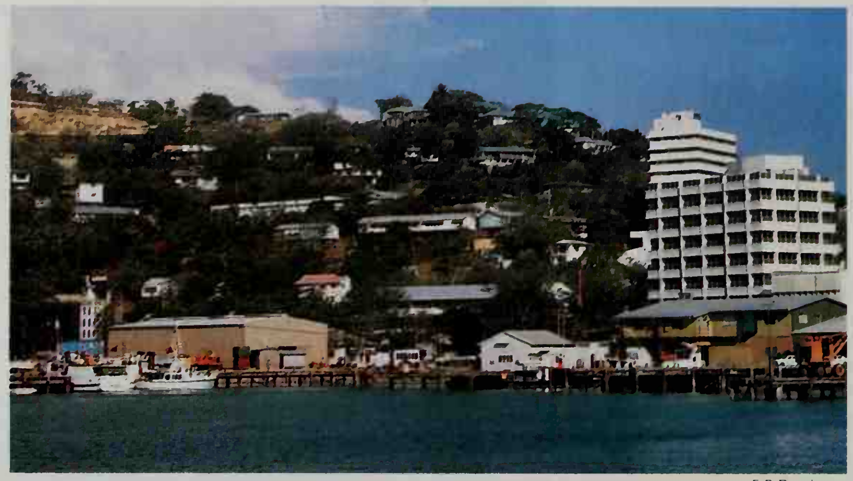
James E. Simon

Papua New Guinea, *PAH poo ah nyoo GIHN ee,* is an independent nation in the Pacific Ocean, north of Australia. It consists of part of the island of New Guinea plus a chain of tropical islands that extend more than 1,000 miles (1,600 kilometers).

The eastern half of New Guinea makes up most of Papua New Guinea's area. The country also includes the islands of the Bismarck Archipelago, Bougainville and Buka in the Solomon Islands chain, the D'Entrecasteaux Islands, the Louisiade Archipelago, the Trobriand Islands, and Woodlark Island. Port Moresby, on New Guinea, is Papua New Guinea's capital and largest city.

The islands that make up Papua New Guinea were Australian territories during much of the 1900's. Papua New Guinea gained its independence in 1975.

Government. Papua New Guinea is a constitutional



Port Moresby, Papua New Guinea's capital and largest city, lies on the hot, humid coast of southeastern New Guinea. Many houses in the city are built on stilts to keep them cooler.

E. R. Degginger

monarchy. The British monarch serves as head of state and is represented on the islands by a governor general. The people elect a national legislature, which elects a prime minister to head the government.

People. About 98 percent of the population of Papua New Guinea are Melanesians. Most of the people live in small rural villages. About 40 percent of the population live in valleys in the country's interior highlands. Most of the people are Christians.

The people of Papua New Guinea speak about 850 languages. To communicate with one another, the people use widely understood languages called *lingua francas.* These languages include Pidgin English (Tok Pisin) and Police Motu. About three-fourths of the people 15 years of age and older can read and write. For the literacy rate, see **Literacy** (table: Literacy rates). More than 80 percent of primary-school age children attend school, but only about 15 percent of secondary-school age children do so.

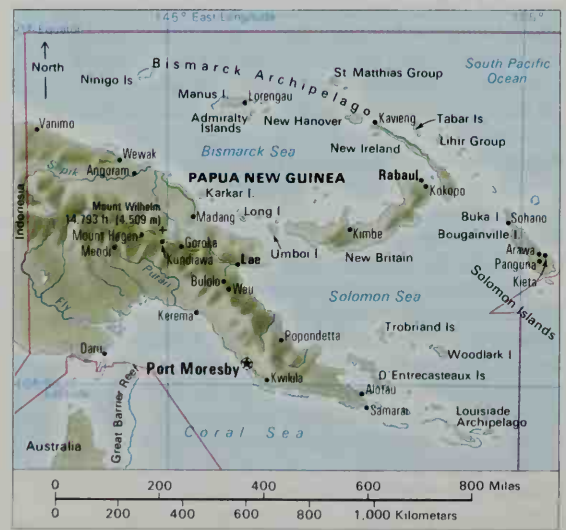
Land and climate. Papua New Guinea's larger islands—including New Guinea, New Britain, and Bougainville—have many high mountain ranges. Volcanoes are common on the northern coasts. Thick tropical forests cover about 80 percent of these islands. Swamps cover much of the coastal land. The country's outlying small islands are the tops of underwater mountains. Many of them are fringed with coral. Papua New Guinea has a hot, humid climate. The temperature averages from 75 to 82 °F (24 to 28 °C) in the lowlands and about 68 °F (20 °C) in the highlands. An average of about 80 inches (203 centimeters) of rain falls annually.

Economy of Papua New Guinea is based largely on agriculture. Most of the people raise crops. They grow most of their own food, including sweet potatoes, yams, and cassava and taro plants. They also produce products that they sell, including cocoa, coconuts, coffee, palm oil, rubber, and tea. Copper, gold, and petroleum are

Papua New Guinea

- ✪ National capital
- • City or settlement
- \+ Elevation above sea level
- — Road





WORLD BOOK maps

Facts in brief

Capital: Port Moresby.
Total land area: 178,704 mi² (462,840 km²). *Greatest distances between islands*—east-west, 1,040 mi (1,674 km); north-south, 730 mi (1,174 km).
Elevation: *Highest*—Mount Wilhelm, 14,793 ft (4,509 m) above sea level. *Lowest*—sea level.
Population: *Estimated 2002 population*—5,015,000; population density, 28 per mi² (11 per km²); distribution, 85 percent rural, 15 percent urban. *1990 census*—3,607,954.
Chief products: *Agriculture*—cocoa, coconuts, coffee, rubber, tea, timber. *Mining*—copper, gold, natural gas, petroleum, silver.
Flag: The flag is divided diagonally from upper left to lower right. A golden bird-of-paradise is in the upper section, which is red. Five stars representing the Southern Cross appear in the lower section, which is black. See **Flag** (picture: Flags of Asia and the Pacific).
Money: *Basic unit*—kina. One hundred toea equal one kina.

the most valuable exports. Gold and copper are mined at Ok Tedi near Papua New Guinea's border with Indonesia. Gold mines also operate at Porgera in the New Guinea central highlands and on the island of Lihir.

Road construction is difficult in Papua New Guinea. Many parts of the country can be reached only by air, foot, or canoe. A national airline operates among the islands. The country has about 15 radio stations, 2 daily newspapers, and 1 commercial television station.

History. People lived in what is now Papua New Guinea at least 50,000 years ago. Farming began there more than 9,000 years ago. The people developed rich traditions of pottery, carving, dance, body decoration, and sea navigation. In the early 1500's, Spanish and Portuguese explorers landed on the islands. The Dutch and English visited the islands during the next 300 years.

In 1884, Germany annexed northeastern New Guinea and the islands off its shore. That same year, the United Kingdom took over southeastern New Guinea and the nearby islands. In 1906, Australia took over administration of the British territory and named it the Territory of Papua. In 1914, during World War I, Australia seized the areas held by Germany. In 1920, the League of Nations officially put these areas under Australian control. Japanese forces invaded the islands in 1942, during World War II. They held much of New Guinea and several of the other islands. After the war ended in 1945, Australia placed northeastern and southeastern New Guinea, along with the nearby islands, under one government.

The islands gained independence as Papua New Guinea on Sept. 16, 1975. In 1988, conflicts over mining and land rights began on Bougainville. The attacks soon grew into a rebellion seeking that island's independence. The government and rebel leaders signed a ceasefire in 1998 and a peace agreement in 2001. Under the peace accord's terms, Papua New Guinea has agreed to grant Bougainville greater *autonomy* (self-rule). The accord also authorizes a referendum to eventually be held on the question of independence. Hank Nelson

Related articles in *World Book* include:

Admiralty Islands
Bougainville
New Britain
New Guinea
New Ireland
Port Moresby
Sculpture (Melanesia; picture: Malagan image)

Papyrus, *puh PY ruhs,* is a water plant whose fibers were used by the people of ancient Egypt to make a writing material. It served also as a material for mats, sandals, and sailcloth for light skiffs. The brownish flowers were made into garlands for the shrines of the Egyptian gods. Many people think the mother of Moses hid her son in an ark made of papyrus.

The papyrus plant still grows in the Nile Valley of Egypt. It is also found in Ethiopia, Syria, southern Italy, and Sicily. The plant's reedlike stems grow 3 to 10 feet (0.9 to 3 meters) high. As many as 100 flower stalks spring from the top of each stem. These stalks may be more than 12 inches (30 centimeters) long. Coarse *bracts* (leaflike structures) surround the cluster of stalks. The flowers grow in clusters at the ends of the stalks.

The Egyptians made a writing material, also called *papyrus,* by laying strips of the plant's stem in layers, and placing them under pressure. The crushed strips matted into a loose-textured, porous, white paper. Time has turned surviving papyrus manuscripts brown and brittle. The paper was sold as long, rectangular sheets of differ-



M. P. Kahl, Photo Researchers

Papyrus is a reedlike water plant that grows in Egypt. Ancient peoples used papyrus fibers as a writing material.

ent sizes. The sheets were at first rolled and tied with a string. Later they were bound together into books. Egypt guarded its monopoly on the preparation of the paper until the 100's B.C. Then papyrus was gradually replaced by the more durable parchment. David A. Francko

Scientific classification. The papyrus plant belongs to the sedge family, Cyperaceae. Its scientific name is *Cyperus papyrus.*

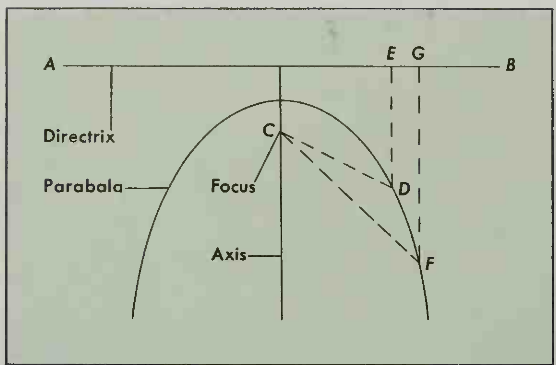
Pará nut. See Brazil nut.

Parable, *PAR uh buhl,* is a brief story, proverb, or saying that expresses a moral. Most parables illustrate difficult or mysterious ideas through situations that can be easily understood. Almost all parables express religious ideas, and the Bible includes many such stories. For example, the Old Testament contains a parable told by Nathan to King David. A rich man had many sheep, but a poor man had only one. The rich man wanted to feed a traveler who called at his door. To do so, he killed the poor man's only sheep, rather than kill one of his own. Nathan was actually comparing the rich man with David, who had married another man's wife (II Sam. 12:1-7).

The best-known parables are those of Jesus Christ in the New Testament. Jesus used simple, everyday situations to express such ideas as the Kingdom of God, the proper use of wealth, and the nature of prayer. For example, he compared Judgment Day to a fisherman's net cast into the sea (Matt. 13:47-50). The net caught all kinds of fish. But after it was pulled to shore, the edible fish were kept and the bad-tasting ones were thrown away. Jesus was saying that on Judgment Day, people who have been saved from damnation will likewise be separated from the damned. Mark E. Workman

Parabola, *puh RAB uh luh,* is one of the curves most used in science. If a ballplayer hits a high fly, the path of the ball is nearly a parabola. Any point on a parabola is equidistant from a line *AB* and point *C.* Line *AB* is the *directrix* and point *C* is the *focus.* The solid line through point *C,* which bisects the parabola, is called the *axis.*

A parabola revolved about its axis generates a *parabolic surface.* A light at the focus of a mirror with this shape would cause the light rays that hit the mirror to reflect parallel to the axis. Scientists use this principle



WORLD BOOK diagram

A parabola is a curve drawn on a plane. The diagram above shows that any point on a parabola is the same distance from the directrix, line *AB,* as it is from the focus, point *C.* Therefore, *CD* equals *DE,* and *CF* equals *FG.*

of the parabolic surface in producing headlight and searchlight reflectors. Philip S. Marcus

Paracelsus, *PAIR uh SEHL suhs,* **Philippus Aureolus,** *fih LIHP uhs aw REE oh luhs* (1493?-1541), was a Swiss physician who introduced the use of drugs made from minerals. His drugs included such minerals as sulfur, mercury, and antimony. Paracelsus challenged the ancient Greek and Roman belief that disease is caused by an imbalance of body *humors* (fluids). He argued that each illness has a specific, external cause.

Paracelsus was the first physician to treat disease with moderate doses of minerals that had been *detoxified*—that is, they had their poisons removed. He also became the first physician to correctly describe chorea, silicosis, congenital syphilis, and tuberculosis.

Many of Paracelsus' theories were criticized, however, because they were based in part on unscientific principles associated with alchemy, astrology, and mysticism (see **Alchemy**). Paracelsus argued that disease is caused by external factors that take possession of part of the body. But he also believed that spiritual forces were among the causes of disease and that he, as a spiritualist, could control them with the use of minerals and herbs.

Paracelsus was born at Einsiedeln, Switzerland. His given and family name was Theophrastus Bombastus von Hohenheim. He received his early education from his father, a physician. John Scarborough

Parachute is a device used to slow the fall of a person or object from an aircraft or any other great height. The operation of a parachute is based on simple principles. There are two forces that act on any falling object—gravity and air resistance. Gravity pulls the object toward the earth. But air resists the object's movement. Because the pull of gravity is much stronger than the resistance of the air, the air can only slow the speed of the falling object. Large surfaces offer the greatest resistance to the air. Thus, the larger the parachute's surface, the more air resistance it meets and the slower it falls.

Uses of parachutes. One of the early uses of parachutes was to allow descent from gas-filled balloons. Since the development of airplanes, parachutes have been used for emergency jumps from damaged aircraft. They have also been used to deliver cargo. Airplanes drop food and medicine by parachute to places that cannot be reached easily by other means. Special military uses for parachutes were developed during the 1930's. Both the Allies and Germans used *paratroops,* or parachute troops, during World War II (1939-1945). Some airplanes use parachutes as brakes when landing. Parachutes are also used to recover the booster rockets from spacecraft that have been launched into the atmosphere. Today, most parachutes are used for sport jumping, called *skydiving.*

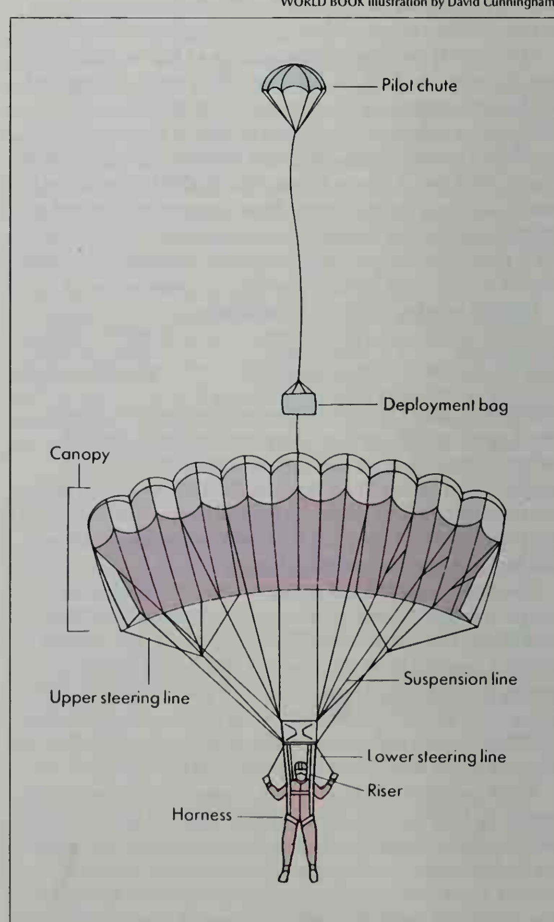
Parts of a parachute. The part of the parachute that catches the air is called the *canopy.* For many years, parachutes had a round canopy that looked somewhat like an umbrella. Today, most canopies have a rectangular shape, somewhat like the wing of an airplane. The front part of a rectangular canopy is cut off, allowing air to enter. The air inflates the canopy and makes it fairly rigid, like an air mattress.

Skydivers generally use a rectangular parachute that is twice as wide as it is deep. Many sport parachutes measure 11 by 22 feet (3.4 by 6.8 meters). Round parachutes, which are used mainly for cargo, may measure up to 100 feet (30 meters) across. Parachute canopies

Parts of a parachute

A sport parachute brings a skydiver down very slowly. When the skydiver pulls the ripcord, the pilot chute opens and pulls out the canopy, which unfolds in a few seconds.

WORLD BOOK illustration by David Cunningham



were once made of silk. But nylon, which is stronger and cheaper, has been used since the early 1940's.

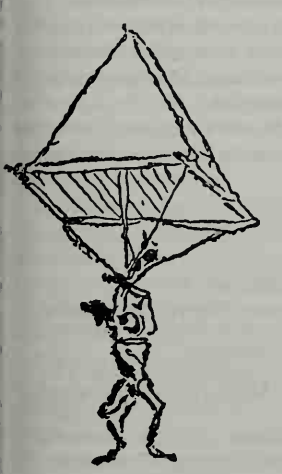
The canopy is packed in a container made of heavy nylon cloth. Special pins called *ripcord pins* hold the container shut. The container is attached to the parachutist's body by a *harness* that fits around the shoulders and legs. Straps called *risers* connect the harness to *suspension lines,* which attach to the canopy. Skydivers wear a main parachute and a reserve parachute for emergencies. The reserve parachute is usually mounted on the back, just above the main parachute.

How parachutes work. Skydivers generally open their parachutes at about 2,500 feet (750 meters). The parachutist reaches into a pouch on the leg strap and pulls out a pilot parachute that measures about 3 feet (0.9 meter) across. This parachute quickly inflates, releases the ripcord pin on the container, and pulls out the canopy. If the main parachute fails, there is time to activate the reserve parachute. After the canopy opens, the ride to the ground takes about 3 minutes. The parachute moves at about 20 miles (32 kilometers) per hour. The parachutist can pull on the right steering line to turn right and on the left steering line to turn left.

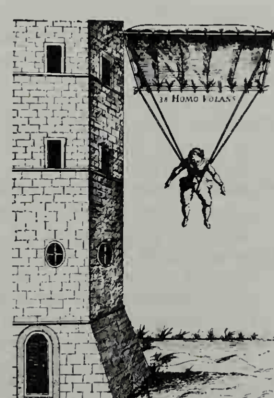
Rectangular parachutes have a greater forward speed than round parachutes and so are not easily blown backward when they encounter wind. Rectangular parachutes also descend more slowly than round parachutes. In landing, the parachutist can pull down the back edge of the rectangular canopy with steering lines. This slows the parachute's motion and permits a gradual, soft landing.

History. As early as the 1100's, the Chinese may have experimented with parachutes by jumping from high structures with rigid, umbrellalike devices. The first known parachute jump was made from a tower in 1783 by the French physicist Sebastian Lenormand. The first parachute jump from a balloon was made in 1797, and the first freefall parachute jump from a damaged airplane in 1922. Dan Poynter

See also **Air** (picture); **Airborne troops**; **Skydiving**.



Leonardo da Vinci drew a sketch, *left,* of a parachute he designed in 1495. He called it a "tent roof."



An early parachute illustration, *right,* was made in 1617 to accompany an article by an Italian experimenter.

U.S. National Air and Space Museum

Parade is a public march or procession honoring a particular occasion. The mood of a parade may vary from joyous excitement to solemn dignity. Members of the armed forces often parade on holidays to show off their strength, condition, equipment, and skill. Many parades have floats, music, marchers, and trained animals.

Parades in the form of religious processions go back to about 3000 B.C. Ancient cities often had special, elaborately constructed streets whose main function was to provide a place for processions. The Romans enjoyed parades, especially the processions of the performers at the circus. They also had frequent military parades, called *triumphs,* during the time of the empire (see **Triumph**). Parades to honor particular feasts became popular in the early Christian church, and remain so today. Political parades were especially popular in the United States in the 1880's and 1890's.

See also **Baton twirling**; **New South Wales** (picture); **Veterans of Foreign Wars of the U.S.** (picture).

Paradise is a name for heaven. It was originally a Persian word used for the amusement parks of Persian kings. The Greeks borrowed the word from the Persians. Greek translators of the Bible used the word paradise in reference to the Garden of Eden (Gen. 2-3). Jewish authors after 200 B.C. saw paradise as a place of reward after death. Early Christian writers used the term in the same sense. For example, in the Gospel of Luke, Jesus is reported as promising paradise to a thief dying on the cross. See also **Heaven**. Joseph M. Hallman

Paradise Lost. See **Milton, John**.

Paraffin, *PAR uh fihn,* is a commonly used term for *paraffin wax,* a white, partly clear material. Paraffin wax forms a moisture-proof film, and is used to make waterproof cardboard containers such as milk cartons. It is also the major ingredient in candles.

The wax is made up of a mixture of substances known by the chemical term *paraffin.* A paraffin is a type of *hydrocarbon* (a substance containing hydrogen and carbon). See **Hydrocarbon**. Paraffin wax comes from *petroleum fractions* (products separated from petroleum). Chilling the fractions and pressing them through a filter removes heavy oil. The remaining solid is paraffin wax.

Ordinary paraffin wax melts at 90 °F to 150 °F (32 °C to 66 °C). *Microcrystalline wax,* which is composed of larger hydrocarbons, melts at 150 °F to 185 °F (66 °C to 85 °C). Geoffrey E. Dolbear

Paragraph is a section of a written work that consists of one or more sentences constructed and arranged to function as a unit. The first line is normally indented. The subject or topic of a paragraph is often stated in the first sentence, called a *topic sentence.* Paragraphs may range in length from a single word used for emphasis, such as "Never!," to several hundred words. However, most paragraphs are from 100 to 200 words long.

An effective paragraph must be unified, ordered, and complete. A paragraph is unified when all the sentences contribute to creating a single idea. A paragraph has order when the sentences form a pattern, such as leading from cause to effect or from the particular to the general. A paragraph is complete when the writer brings its idea clearly into focus. William E. Coles, Jr.



Luis Villota, The Stock Market

The skyline of Asunción, Paraguay's capital and largest city, consists of modern high-rises and traditional Spanish-style buildings. About a fifth of all Paraguayans live in or near Asunción.

Paraguay

Paraguay, *PAIR uh GWAY* or *PAIR uh GWY,* is a small landlocked country near the center of South America. It is surrounded by Argentina, Bolivia, and Brazil. The Paraguay River flows through Paraguay from north to south and divides the country into two sharply different land regions. West of the river lies the Chaco, a flat, thinly settled area of coarse grasses, scrub forests, and salt marshes. Eastern Paraguay, on the other hand, has rolling hills, fertile soil, and thick forests.

The great majority of the Paraguayan people live in the eastern part of the country. About a fifth of them live in or near Asunción, the capital and largest city. Almost all Paraguayans are of mixed Guaraní Indian and Spanish ancestry. The Guaraní Indians were the original inhabitants of what is now Paraguay. They intermarried with Spanish settlers, who began to arrive in the 1500's. Most Paraguayans speak both Guaraní and Spanish. Nearly all the people are Roman Catholics.

Paraguay is a poor country whose economy is based chiefly on agriculture and forestry. About half the people of Paraguay live in rural areas, and most of them make a bare living farming. The country's most valuable resources are fertile soil, dense forests, and vast hydroelectric power potential. These resources could provide for strong economic growth in Paraguay if they were more developed.

Spain ruled Paraguay until 1811, when Paraguay declared its independence. Over the years, the country has suffered from terrible wars with neighboring nations and from struggles for power among rival political groups.

Richard W. Wilkie, the contributor of this article, is Professor of Geography at the University of Massachusetts at Amherst.

Government

National government. Paraguay's Constitution, adopted in 1992, provides for a democratic form of government. Under the Constitution, voters elect the president, Paraguay's head of government, to a five-year term. The president may not be reelected.

The president appoints a cabinet called the Council of Ministers. The cabinet members head the government

Facts in brief

Capital: Asunción.
Official languages: Spanish and Guaraní.
Official name: República del Paraguay (Republic of Paraguay).
Area: 157,048 mi² (406,752 km²). *Greatest distances*—north-south, 575 mi (925 km); east-west, 410 mi (660 km).
Elevation: *Highest*—2,231 ft (680 m) above sea level near Villarrica. *Lowest*—180 ft (55 m), at the meeting point of the Paraguay and Paraná rivers.
Population: *Estimated 2002 population*—5,770,000; density, 37 per mi² (14 per km²); distribution, 52 percent urban, 48 percent rural. *1992 census*—4,152,588.
Chief products: *Agriculture and forestry*—cassava, corn, cotton, livestock, rice, soybeans, sugar cane, timber trees, tobacco, wool. *Manufacturing*—cement, leather goods, processed foods and beverages, textiles, wood products.
National anthem: "¡Paraguayos, república o muerte!" ("Paraguayans, Republic or Death!").
Money: *Basic unit*—guaraní. One hundred centimos equal one guaraní.

departments and assist the president in carrying out the operations of Paraguay's government.

Paraguay's legislature, called the National Congress, consists of a 45-member Senate and an 80-member Chamber of Deputies. Voters elect the members to five-year terms.

Local government. Paraguay is divided into 17 departments for the purposes of local government. Voters elect a governor to be the head of each department. The departments are subdivided into smaller units of government.

Politics. The National Republican Association, popularly called the Colorado Party, is Paraguay's largest single political party. It dominated the country's politics from 1947 to 1993, when the first democratic, multiparty elections were held. The Democratic Alliance, a coalition of political parties, forms the main opposition to the Colorado Party. The law requires all citizens of Paraguay 18 years of age and older to vote.

Courts. The Supreme Court Justice is Paraguay's highest court. It has nine justices. The justices are appointed by the Senate from candidates that are proposed by a council of government representatives, lawyers, and law professors. The Supreme Court justices serve until age 75.

Armed forces. Paraguay's armed forces have about 20,000 men. Men are drafted at age 18 and serve one year in the country's army or air force, or two years in the navy.

People

Population and ancestry. More than 95 percent of Paraguay's people live in the eastern part of the country. The rest live in the west, or the Chaco, where poor soil, an arid climate, and a lack of roads have discouraged settlement.

The Guaraní Indians lived in what is now Paraguay long before the first Spanish settlers arrived in the 1500's. Over the years, a large number of Indians and Spaniards intermarried. Today, about 95 percent of all Paraguayans are *mestizos* (persons of mixed white and Indian ancestry). A small number of people of unmixed Indian ancestry live in the Chaco. People of Chinese, German, Korean, and Japanese descent also make up minorities in Paraguay.

Languages. Paraguay has two official languages—Spanish and Guaraní. Spanish is used in the schools, in government, and in commerce. But people throughout Paraguay generally use Guaraní in everyday conversation. Books, newspapers, and magazines are published in both languages.

Way of life. Paraguay has a large lower class, which consists of nearly all rural people and most city dwellers. Middle-class Paraguayans, most of whom live in urban areas, form a small but growing portion of the population. The nation's tiny upper class consists chiefly of government officials, military leaders, and wealthy landowners and business people.

Rural life. Most Paraguayans who live in rural areas are farmers who grow food mainly for their own families. Other rural Paraguayans work on cattle ranches, on large farms that produce crops for export, in forestry, or in small factories that process farm or forest products.

Most rural Paraguayans live in one-room houses



Luis Acuña, Latin Focus

The Government Palace is one of the many government buildings in Asunción. The palace, which was completed in 1892, houses the office of the president of Paraguay.





Symbols of Paraguay. Paraguay's flag has the coat of arms on the front, *left,* and the Treasury seal on the back. It is the only national flag with a different design on each side. The star on the coat of arms, *right,* stands for independence from Spain.



WORLD BOOK map

Paraguay lies near the center of South America. It is surrounded by Argentina, Bolivia, and Brazil.

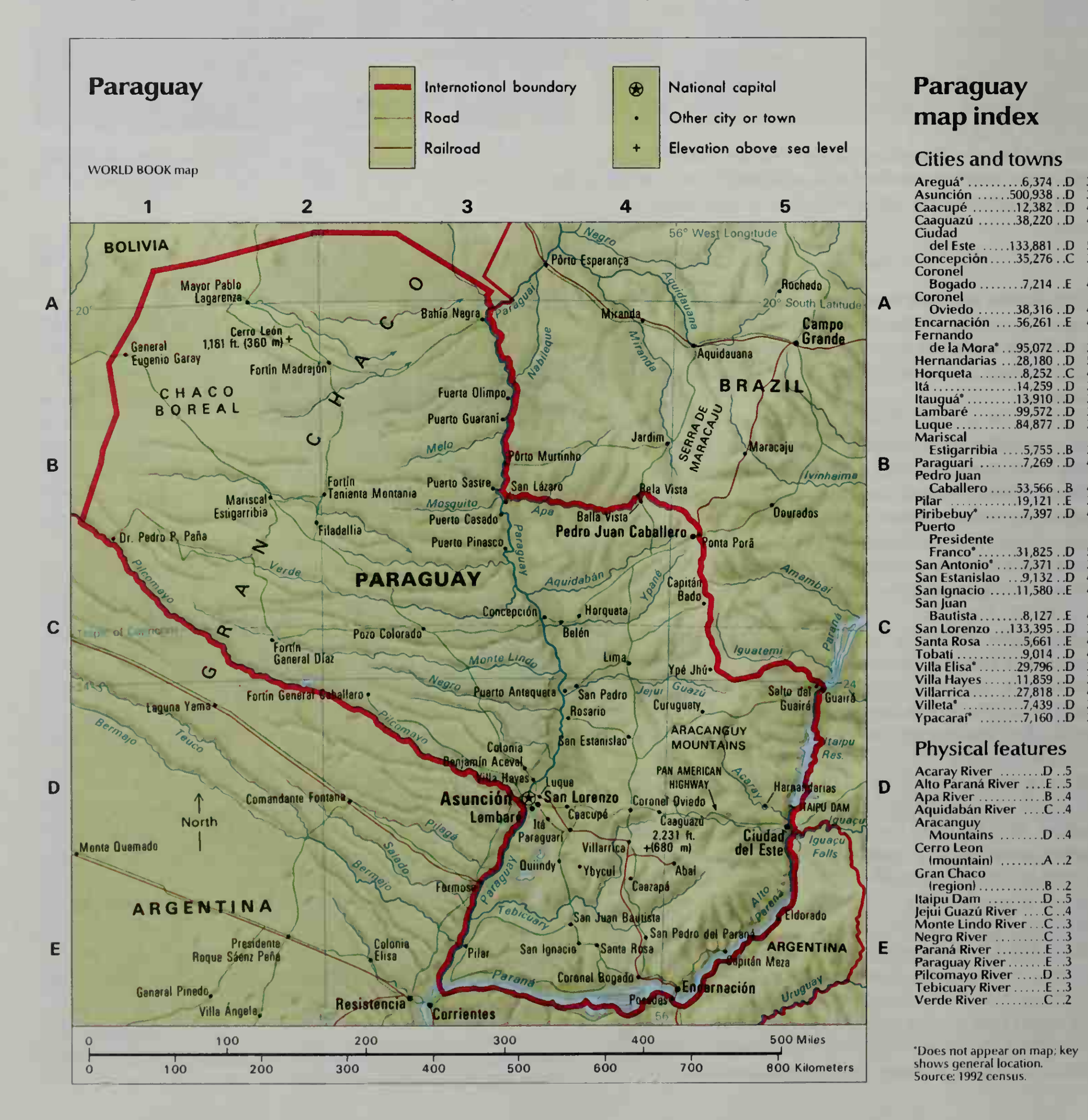
called *ranchos.* A typical rancho has a dirt floor; reed, wood, or brick walls; and a thatch roof sloped to carry off heavy rains. A separate or attached shed serves as a kitchen. Few houses have indoor plumbing.

City life. About half of the people of Paraguay live in cities and towns. Asunción, the capital, is the largest city by far. It has about half a million people. Other major cities include Ciudad del Este, Fernando de la Mora, Lambaré, and San Lorenzo. City dwellers include craftworkers, unskilled laborers, factory workers, government employees, office workers, shopkeepers, and professional people. In general, urban Paraguayans have a higher standard of living than do the people in rural areas. The cities have better schools, more medical facilities and other services, and a variety of cultural and recreational activities.

Many city people live in small, pastel-colored houses made of brick or stucco. The houses have red tile roofs, and iron grillwork covers the windows. The poorest people live in shacks built of scraps of wood or metal. Unlike many other large Latin-American cities, Asunción does not have sprawling slum areas.

Clothing. Urban Paraguayans dress as people do in the United States and Canada. Many rural women wear a shawl, called a *rebozo,* and a simple dress or a skirt and blouse. Rural men generally wear loose trousers, called *bombachas,* a shirt or jacket, a neckerchief, and a poncho. Most rural Paraguayans go barefoot.

Food and drink. Paraguayans eat much meat, especially beef. Beef is often cooked with vegetables in a stew called *puchero.* Another common food is *cassava,* a starchy root vegetable. Cassava may be boiled or ground into flour and made into a kind of bread called *chipá. Sopa paraguaya,* often served on special occasions, consists of corn meal cooked with eggs, milk, onions, and cheese. The favorite beverage is a tea called *yerba maté* or simply *maté.* It is made from the leaves of a holly tree that grows in the eastern forests.



Paraguay map index

Cities and towns

Areguá*	6,374	D	3
Asunción	500,938	D	3
Caacupé	12,382	D	4
Caaguazú	38,220	D	4
Ciudad del Este	133,881	D	5
Concepción	35,276	C	3
Coronel Bogado	7,214	E	4
Coronel Oviedo	38,316	D	4
Encarnación	56,261	E	4
Fernando de la Mora*	95,072	D	3
Hernandarias	28,180	D	5
Horqueta	8,252	C	4
Itá	14,259	D	3
Itauguá*	13,910	D	3
Lambaré	99,572	D	3
Luque	84,877	D	3
Mariscal Estigarribia	5,755	B	2
Paraguarí	7,269	D	4
Pedro Juan Caballero	53,566	B	4
Pilar	19,121	E	3
Piribebuy*	7,397	D	4
Puerto Presidente Franco*	31,825	D	5
San Antonio*	7,371	D	3
San Estanislao	9,132	D	4
San Ignacio	11,580	E	4
San Juan Bautista	8,127	E	4
San Lorenzo	133,395	D	3
Santa Rosa	5,661	E	4
Tobatí	9,014	D	4
Villa Elisa*	29,796	D	3
Villa Hayes	11,859	D	3
Villarrica	27,818	D	4
Villeta*	7,439	D	3
Ypacaraí*	7,160	D	3

Physical features

Acaray River	D	5
Alto Paraná River	E	5
Apa River	B	4
Aquidabán River	C	4
Aracanguy Mountains	D	4
Cerro Leon (mountain)	A	2
Gran Chaco (region)	B	2
Itaipu Dam	D	5
Jejui Guazú River	C	4
Monte Lindo River	C	3
Negro River	C	3
Paraná River	E	3
Paraguay River	E	3
Pilcomayo River	D	3
Tebicuary River	E	3
Verde River	C	2

*Does not appear on map; key shows general location.
Source: 1992 census.

Recreation. Soccer is the favorite sport in Paraguay. The people also enjoy basketball, volleyball, horse racing, and swimming. Paraguayans celebrate religious holidays with festivals that often include music, dancing, parades, and athletic contests.

Religion. Over 90 percent of the Paraguayan people are Roman Catholics. The Constitution makes Catholicism the state religion, but it guarantees freedom of worship. Protestants, many of whom are Mennonites, make up about 1 percent of the population.

Education. Most Paraguayans over age 15 can read and write. For the country's literacy rate, see **Literacy** (table: Literacy rates). Paraguay's government provides free public schooling through the university level. The country also has many private schools, which charge tuition. The law requires children from the ages of 7 through 13 to attend school. But the law is not strictly enforced, especially in rural areas. Many rural children never attend school or drop out to help their families farm the land. In addition, numerous rural areas have teacher shortages, and some have no schools at all. Paraguay has two universities—the National University of Asunción and Catholic University. Catholic University operates in Asunción, Villarrica, Concepción, Encarnación, and Pedro Juan Caballero.

The arts. Various Paraguayan arts show the influence of the Guaraní Indian culture. Popular music, for example, has a slow rhythm and is played in a sad minor key typical of traditional Guaraní music. Artists commonly portray Guaraní culture in their paintings. Craftworkers use Guaraní designs in producing fine pottery and handwoven baskets. Paraguay's most famous handicraft, however, is *ñandutí* lace, made by the women of the town of Itauguá. *Ñandutí* means *spider web* in Guaraní. The complicated patterns of ñandutí lace represent flowers, animals, and other familiar objects.

Spanish missionaries, who began to arrive in Paraguay in the 1500's, developed a written form of the Guaraní language. However, Guaraní was not used in literary works until the 1900's, and Guaraní literature today is little known outside Paraguay. Many Paraguayan literary works written in Spanish deal with events in the country's history.

The land and climate

Land regions. The Paraguay River flows southward through Paraguay. It divides the country into two major regions: (1) the Chaco, officially called Occidental Paraguay, and (2) Eastern Paraguay, officially called Oriental Paraguay.

The Chaco stretches westward from the Paraguay River. It is part of the Gran Chaco, a large region that extends into Argentina and Bolivia. The Chaco occupies about three-fifths of Paraguay but has less than 5 percent of its population. Coarse grasses, scrub forests, and thorny shrubs cover much of the Chaco. The forests include quebracho trees. Quebrachos are a source of *tannin,* a chemical used to process leather.

Several slow-moving rivers flow through the southern and eastern Chaco. The Pilcomayo River forms Paraguay's southwestern border with Argentina. The Pilcomayo and other rivers in the Chaco often overflow after heavy rains in the summer. Some of the rivers disappear during the winter dry season, and salt marshes form. In



Luis Villota, The Stock Market

A Paraguayan lacemaker carefully creates a complicated flower pattern in a piece of ñandutí lace. The making of ñandutí lace is a tradition begun by Paraguay's Guaraní Indians.

much of the Chaco, the underground water is too salty for drinking or irrigation. Cattle ranches occupy parts of the region, mainly in the south. German-speaking people of the Mennonite faith have established several farming communities in the central Chaco, and scattered tribes of Guaraní Indians live in remote parts of the region. But most of the Chaco is uninhabited.

Eastern Paraguay lies between the Paraguay River and the Paraná River. The Paraná forms part of Paraguay's border with Argentina and Brazil. The river flows through Argentina to the Atlantic Ocean. The Paraná thus provides Paraguay with an outlet to the sea. The heavily forested Paraná Plateau occupies the eastern third of the region. The rest of the region consists of low, grassy plains and forested hills.

More than 95 percent of all Paraguayans live in Eastern Paraguay. Most of them live along the Paraguay River or in the southwestern part of the region, where small towns and farming villages dot the rolling countryside. Asunción lies on the Paraguay River, near the point where it meets the Pilcomayo River.

Climate. Most of Paraguay has a warm, humid climate. The Chaco is the hottest and driest part of the country, and the Paraná Plateau is the coolest and wettest. Paraguay lies south of the equator, and so its seasons are opposite those in the Northern Hemisphere. Temperatures in Asunción average 65 °F (19 °C) in July and 84 °F (29 °C) in January.

Eastern Paraguay receives about 50 to 65 inches (127 to 166 centimeters) of rain annually. The rain falls throughout the year in the region. The Chaco receives about 20 to 40 inches (51 to 102 centimeters) of rain yearly. It often has winter droughts and summer floods.

Economy

Paraguay has a developing economy. Service industries and agriculture, including forestry, account for most of the nation's *gross domestic product* (GDP)—the total value of all goods and services produced in the country yearly. Many businesses and industries are pri-

vately owned. However, the national government plays a major role in economic planning and development. It also owns firms in such fields as banking, manufacturing, transportation, and energy production.

Service industries account for about 55 per cent of Paraguay's GDP and employ about 45 per cent of the work force. Many of the workers are employed by government agencies; stores, restaurants, and hotels; banks; health care facilities; and schools. Others work in such fields as transportation and communication.

Agriculture and forestry largely form the basis of Paraguay's economy. They account for about 30 per cent of the nation's GDP, and they employ about 45 per cent of all of Paraguay's workers. Large cattle ranches cover parts of the Chaco and much of Eastern Paraguay. Eastern Paraguay has the country's best soil. Farmers grow such crops as cassava, corn, cotton, rice, soybeans, sugar cane, and tobacco.

Farms occupy only about a fifth of the land that could be used in Paraguay to grow crops. One reason is that many farmers do not raise much more food than they need for their families. In addition, the use of old-fashioned tools and methods keeps farmers from cultivating as much land as could be farmed. Many farmers do not own or even rent their land. Instead, they are *squatters* on public or private land. They work small plots until the soil is no longer productive, then move on to another area. Since the mid-1900's, government programs have encouraged farmers to use modern tools and methods and to buy land in undeveloped areas.

Forests cover about half of Paraguay and rank among the country's most valuable natural resources. Many kinds of trees are cut for lumber. Quebracho trees, which grow mainly in the Chaco, are harvested for tannin, which is used to tan hides. Holly tree leaves are used to make yerba maté tea. Other valuable trees in Paraguay include cedars, coconut palms, and wild citrus trees.

Manufacturing accounts for about 15 per cent of Paraguay's GDP and employs about 10 per cent of its workers. The largest factories are in or near Asunción. Major manufactured goods include cement, leather goods, processed food and beverages, textiles, and wood products.

Energy sources. Hydroelectric power plants on the Acaray and Paraná rivers provide Paraguay with plentiful electricity. In addition, the country has enormous potential for further hydroelectric power development. The Itaipú Dam power plant, which was built by Paraguay and Brazil on the Paraná River, is one of the world's largest hydroelectric power projects. The plant began generating electricity in 1984 and was completed in 1991. Itaipú has the capacity to generate about $12\frac{1}{2}$ million kilowatts of electricity.

Trade. Paraguay's chief exports include coffee, cotton, lumber, meat products, soybeans and other oilseeds, tannin, tobacco, and vegetable oils. Its leading imports include chemicals, fuels and lubricants, iron and steel, machinery, and transportation equipment. Paraguay trades mainly with Argentina, Brazil, the United States, and western European countries.

Transportation and communication. Rivers serve as an important means of transportation in Paraguay. Asunción, the main port, lies on the Paraguay River about 1,000 miles (1,600 kilometers) from the Atlantic Ocean. To reach the ocean from Asunción, boats travel down the Paraguay to the Paraná River, which flows through Argentina and empties into the Atlantic. Paraguay's major cities are connected by paved highways, but less than a fifth of the country's roads are paved. Less than 2 per cent of all Paraguayans own an automobile. Friendship Bridge spans the Paraná River at the city of Cuidad del Este. It links the Paraguayan road system to a Brazilian highway that runs to the port of Paranaguá on the Atlantic coast. Paraguay's only major railroad carries passengers and freight between Asunción and Encarnación. An airport near Asunción handles international flights.

Paraguay has four daily newspapers. About 5 per cent of the people own a radio, and less than 3 per cent own

Luis Villota, The Stock Market



Cattle ranching is a major economic activity in Eastern Paraguay. The low, grassy plains that cover much of the region are ideal for cattle grazing.

a television set. The nation's Constitution guarantees freedom of the press.

History

Early days. Guaraní Indians were the first people to live in what is now Paraguay. They were fairly peaceable people who grew corn and other crops, hunted game, fished, and gathered wild fruits. In the early 1500's, Spanish and Portuguese explorers became the first whites to reach Paraguay. They were searching for a route across the continent to Peru and its treasures of silver and gold. In 1537, a Spaniard named Juan de Ayolas traveled up the Paraná and Paraguay rivers to a point north of what is now Asunción. He then went inland across the Chaco region. The men he left behind built a fort at Asunción. Under the leadership of Domingo Martínez de Irala, the settlement of Asunción became the seat of government for all of Spain's colonies in southeastern South America.

The Jesuits. Missionaries of the Jesuit order began to arrive in Paraguay in 1588 to convert the Guaraní to Roman Catholicism. They organized mission settlements called *reducciones* or *reductions,* where the Indians lived and worked. The Jesuits taught the Guaraní such skills as weaving, carpentry, and printing. Most of the Indians farmed the land or tended cattle. In return, they received food, clothing, and other goods. The reducciones became prosperous settlements that exported cotton, tobacco, yerba maté, hides, and wood. By the 1730's, the Jesuits had built about 30 reducciones with a total population of about 140,000.

Many Spanish colonists came to envy the wealth and power of the Jesuits. They wanted to use the cheap Indian labor themselves on their farms. The Jesuits, on the other hand, felt they were protecting the Indians from possible slavery and formed armies to guard the reducciones. Complaints from the colonists about the Jesuits' power led the Spanish king, Charles III, to expel the Jesuits from all Spanish territory in 1767. The Jesuits left Paraguay, and the reducciones were abandoned. Some Indians returned to their old ways of life. Others worked on estates of the Spanish colonists.

Independence. Throughout the 1600's and 1700's, many Paraguayans felt that Spain neglected their colony, and they resented the taxes the mother country demanded. In 1776, Spain made Paraguay part of one large colony called the Viceroyalty of La Plata. Buenos Aires, Argentina, became the capital of the viceroyalty. Paraguayans disliked having to take orders from Buenos Aires. In 1811, they overthrew the Spanish governor in Asunción and declared their independence. They formed an assembly to rule their new nation.

In 1814, the assembly chose José Gaspar Rodríguez de Francia, a Paraguayan lawyer, to head the government. Two years later, the assembly made him dictator for life. Francia governed by military force. He distrusted foreigners, and so he prohibited immigration and forbade trade with other nations. Paraguay was isolated from the rest of the world, but it developed a strong sense of unity and independence.

Francia died in 1840. An assembly chose Carlos Antonio López to govern the country. In 1844, another assembly adopted a republican Constitution and named López president. Like Francia, López ruled as a dictator, but he



James Nachtwey, Black Star

A farmworker cuts sugar cane on a Paraguayan plantation. Sugar cane and such crops as rice, cotton, and tobacco grow well in Paraguay's fertile soil and warm, humid climate.

reversed Francia's policies. López encouraged trade and invited foreign technicians to settle in Paraguay. He also built roads and schools and created a powerful army.

Military ruin. López died in 1862. The Paraguayan legislature then elected his son Francisco Solano López president with dictatorial powers. López resented Paraguay's larger neighbors, Argentina and Brazil, and wanted to increase his country's influence in the region. In 1864, he went to war with Brazil. After Argentina refused to let Paraguayan troops cross its territory to attack Brazil, López declared war on Argentina. Argentina, Brazil, and Uruguay joined forces in 1865 and fought Paraguay in the War of the Triple Alliance, also called the Paraguayan War. The war lasted until 1870, when López was killed and Paraguay surrendered. The war left Paraguay in ruins. The population dropped from about 525,000 in 1865 to about 220,000 in 1871.

After the war, the country was plagued by struggles for power among rival political groups. More than 30 presidents headed the government of Paraguay from 1870 to 1932.

A dispute over ownership of the Chaco led Paraguay into war with Bolivia in 1932. Paraguay again suffered many casualties. The two nations signed a truce in 1935. A final settlement in 1938 gave Paraguay new territory in the Chaco.

Political unrest continued to trouble Paraguay after the Chaco War. A series of presidents again governed the country amid widespread complaints of low living standards, inadequate public services, and poor working conditions. Paraguay's economy improved during World War II (1939-1945). The United States provided loans and other aid to secure Paraguay's friendship. Paraguay declared war on Germany and Japan in 1945, but no Paraguayan troops fought in the war.

Civil war broke out in Paraguay in 1947 as rebels attempted to overthrow President Higinio Morínigo, who had ruled as dictator since 1940. The revolt was crushed. However, the Colorado Party, which had supported Morínigo, split into two groups. Morínigo was eventu-

ally forced to leave the country, and the rival Colorado groups fought for control of the government. Federico Chaves, the leader of one group, seized power in 1950. General Alfredo Stroessner, commander in chief of the armed forces and head of the other group, forced Chaves to resign in 1954. Stroessner ran as the Colorado candidate in elections later that year and was elected president without opposition.

Stroessner's rule and overthrow. Stroessner used military and police powers to keep control of the government and was reelected seven times between 1958 and 1988. The government imprisoned many of its opponents and sent others into exile. By maintaining political stability, Stroessner was able to attract foreign aid and investments and so begin a broad program of economic development. The government started projects to modernize agriculture, build roads, and promote new industries.

Through the years, a growing number of Paraguayans called for greater political and human rights. In 1989, Stroessner was overthrown during a coup led by General Andrés Rodríguez Pedotti, who became president.

Paraguay adopted a new constitution in June 1992, and the country has held regular democratic, multiparty elections since 1993. The Colorado Party's presidential candidate has won each of the elections.

In 1999, Vice President Luis María Argaña was assassinated. The National Congress blamed President Raúl Cubas Grau and the former army chief, Lino Oviedo Silva, for planning the assassination. Cubas resigned, and both he and Oviedo fled the country. Senate President Luis González Macchi then succeeded to the presidency of Paraguay. Richard W. Wilkie

Related articles in *World Book* include:

Asunción
Gran Chaco
Maté
Paraguay River
Paraná River
Quebracho
Tupí-Guaraní Indians

Outline

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Questions

How has Guaraní culture influenced the arts in Paraguay?
What is the ancestry of almost all Paraguayans?
Why do few people live in the Chaco region of Paraguay?
Why do farms occupy only about a fifth of the land that could be used to grow crops in Paraguay?
What were *reducciones*?
What are Paraguay's two main languages?
How did Alfredo Stroessner's rule affect Paraguay?
Why did Paraguay go to war with Bolivia in 1932? What did Paraguay gain as a result of the war?
Why did Spanish and Portuguese explorers come to Paraguay?
How do Paraguayans celebrate religious holidays?

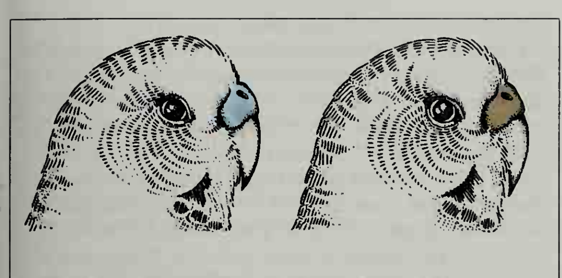
Paraguay River, *PAIR uh GWAY* or *PAIR uh GWY,* is a waterway that flows south through Paraguay, cutting the country in two. It is a branch of the Paraná River and rises in south-central Brazil. From there, it flows south and joins the Paraná at the Argentine boundary. The Paraguay is 1,584 miles (2,549 kilometers) long. The Paraguay is a good river for navigation, except for channel shifts. Large steamboats go up the Paraná and continue on the Paraguay to Asunción, the capital of Paraguay. See also **Paraná River.** Richard W. Wilkie

Parakeet, *PAIR uh keet,* is a small member of the parrot family. Parakeets are brightly colored birds with

Slatyheaded parakeet
Psittacula himalayana
Found from Northwest India to Thailand and Laos
Body length: 15 inches (38 centimeters)

Budgerigar
Melopsittacus undulatus
Found in Australia
Body length: 7 inches (18 centimeters)

WORLD BOOK illustration by Guy Tudor



The sex of an adult budgie can usually be told by the color of the *cere,* the patch of skin just above the beak. In males it is bluish, and in females it is brownish.

WORLD BOOK illustration by Mary Ann Olson

green, red, blue, orange, yellow, or purple feathers. Their tails are either short and square, or long and pointed. The name also is spelled *parrakeet,* or *paroquet.*

Parakeets usually are affectionate and clever pets. They are natural acrobats, and can do many tricks on toy ladders and seesaws. The most common pet parakeet is the *budgerigar,* or *budgie.* This bird is native to Australia. It is also called the *budgerygah,* or *shell parakeet.* It lives well in captivity and becomes very tame.

You can tell the sex of an adult budgie by the color of the skin at the nostrils. This patch of skin is called the *cere.* In the male the cere is bluish, while in the female it is brownish. Most budgies can be trained to talk. It is best to start when the bird is only a few weeks old. Say the same word or phrase over and over until the budgie repeats it. Both the male and the female can learn many words. Some trainers believe males learn faster.

Many people enjoy the hobby of parakeet breeding. Amateur parakeet breeders often find the hobby both fun and profitable. The best time of the year for breeding is in the spring. Birds hatched in the spring will benefit from the sun and warmth of the summer. Special housing for the birds is necessary, because the space for one bird is inadequate for two. The female bird lays an average of five eggs. The eggs hatch in about 18 to 20 days. A parakeet may live 10 years or more.

Seeds and fruit are the chief parakeet foods. Wild parakeets nest in trees and are swift fliers. Many species live in warm parts of the world. The *ground parakeet* of Australia and Tasmania nests in bushes. The *lovebird* is a small, colorful African parakeet. One of the largest parakeets is the *slatyheaded parakeet* of India, Thailand, and Laos. The tiny *hanging parrot* of Southeast Asia is a parakeet that sleeps hanging upside down from a tree branch.

The *Carolina parakeet* once was common in the United States, ranging northward to New York and Illinois. The head of this parakeet was orange and yellow, and its body green. These parakeets have disappeared. Many of them were killed because milliners wanted their feathers for hat trimming. The last flock was seen in the Florida Everglades in 1904, but some of these parakeets may have survived until about 1920.

Scientific classification. Parakeets belong to the family Psittacidae. The Carolina parakeet is *Conuropis carolinensis.* Hanging parrots are genus *Loriculus.* Indian parakeets and lovebirds are *Agapornis.* Shell parakeets are *Melopsittacus,* and ground parakeets are *Pezoporus.* John W. Fitzpatrick

See also **Bird** (picture: Birds as pets); **Lovebird.**

Parallax, *PAIR uh laks,* is the difference in direction of an object when seen from two positions that are not in a direct line with each other and the object. Hold up one finger. Look at it first with one eye and then with the other. Notice how the finger seems to change position in relation to more distant objects when seen with one eye and then with the other.

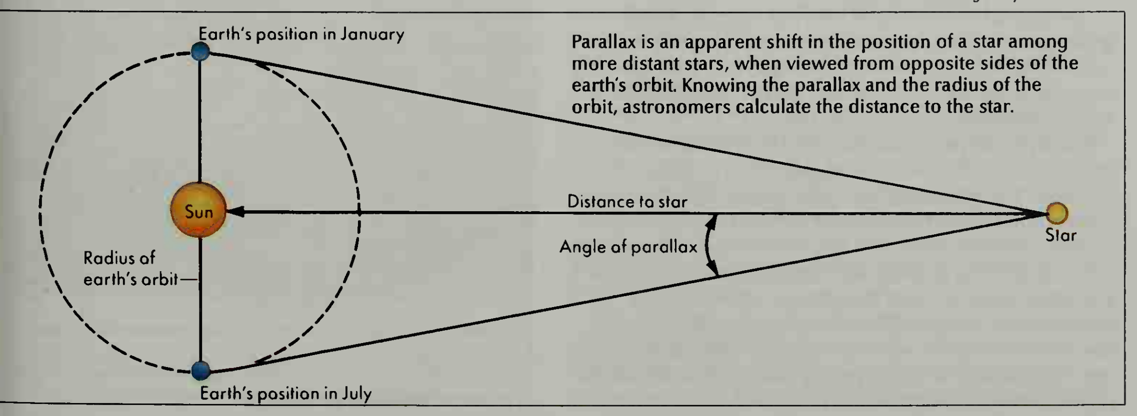
When you look with two eyes, each eye sees nearby things from a slightly different direction. Your mind solves a parallax problem when you look at nearby objects, and you tell how far away they are. A person blind in one eye has no parallax vision, and may have difficulty judging the distance of nearby objects.

Parallax is used in surveying to tell how far away a distant object is. A base line of known length is laid off, the far-off object is viewed from each end of this base line, and the two angles with the base line are noted. Knowing the length of the base line and the number of degrees in the angles at each end, the height of the triangle can be solved by trigonometry.

Parallax is used in astronomy for finding the distance to the stars. For a base line, astronomers use the distance across the entire orbit of the earth around the sun, which is 186 million miles (299 million kilometers) long. But the stars are so far away that this base line is big enough to get the parallax only of some of the nearer

Using parallax in astronomy

WORLD BOOK diagram by Sarah Woodward



Parallax is an apparent shift in the position of a star among more distant stars, when viewed from opposite sides of the earth's orbit. Knowing the parallax and the radius of the orbit, astronomers calculate the distance to the star.

stars. The parallax of the star nearest the sun, Proxima Centauri, is only $\frac{1}{5000}$ of a degree. Howard Turner

See also **Astronomy** (Units of distance); **Photography** (Cameras).

Paralysis, also called *motor paralysis,* is the loss of the ability to move *voluntarily* (under conscious control). It involves loss of control or function of the skeletal muscles, sometimes called *voluntary muscles* (see **Muscle** [Skeletal muscles]). Paralysis may be partial or complete, and temporary or permanent. It can affect any muscles and, in many cases, is associated with loss of sensation in the affected part of the body.

In order to move, a muscle must be stimulated by nerves. Paralysis can result from damage to (1) the central nervous system, (2) the peripheral nervous system, or (3) the muscles themselves.

Paralysis of central nervous system origin can be extensive. The central nervous system consists of the brain and the spinal cord. An injury or disease that destroys brain cells may paralyze arm, leg, and face muscles, often on only one side of the body. Such brain damage generally produces *spastic paralysis,* in which the muscles are more stiff than normal, and reflexes are overactive. If *motor nerve cells* (nerve cells that affect movement) in the spinal cord are damaged directly, then the muscles become limp, and reflexes are lost. This is called *flaccid paralysis.*

Disease of or injury to the spinal cord paralyzes the muscles at and below the level of damage. For example, spinal cord damage in the neck region can cause *quadriplegia*—paralysis of the arms and legs. *Paraplegia*—paralysis of the legs—follows damage to the spinal cord below the neck. Damage to the *brain stem*—the portion of the brain that connects to the spine—can result in the paralysis of muscles that control such automatic functions as breathing and swallowing.

Many conditions can produce paralysis of central nervous system origin. In newborns, such paralysis usually results from injury to the brain during the birth process or from brain hemorrhages in infants born prematurely. It can also result from spina bifida or other birth defects. Among children and young adults, automobile and sports accidents are leading causes of paralysis. Diseases that affect the central nervous system, such as meningitis and multiple sclerosis, also cause many cases of paralysis in young adults. Among older people, strokes and tumors are common central nervous system disorders resulting in paralysis.

Nerve cells in the central nervous system cannot regrow, and so their destruction generally results in permanent paralysis. However, some patients who have suffered brain damage can relearn certain movements by using undamaged parts of the brain.

Paralysis of peripheral nervous system origin generally affects an individual muscle or a group of muscles. The peripheral nervous system includes the nerves that connect the central nervous system to the muscles. Peripheral nerves can be damaged by various poisons, such as alcohol and lead; by diabetes and certain other diseases; and by cuts and other injuries. Inflammation of a peripheral nerve may also paralyze the muscles that the nerve controls. Peripheral nerves can regrow, and so this type of paralysis may be temporary in some cases. Physical therapy can help patients restore their strength if movement returns.

Paralysis of muscular origin. A group of hereditary disorders called *muscular dystrophy* ranks as the most common cause of paralysis due to muscle damage. For information on these disorders, see the article on **Muscular dystrophy.** Richard D. Penn

See also **Cerebral palsy; Palsy; Spastic paralysis.**

Paramaribo, *PAIR uh MAIR uh BOH* (pop. 180,000), is the capital, largest city, and chief port of Suriname, a country in northeastern South America. Nearly half of the people in Suriname live in Paramaribo. The city lies on the Suriname River, 12 miles (20 kilometers) inland from the Atlantic Ocean. For location, see **Suriname** (map). Industrial firms in Paramaribo manufacture aluminum, plywood, and various other products. The city is the home of the University of Suriname and the Suriname Museum. Paramaribo grew up around a British fort built in the mid-1600's. After the abolition of slavery in Suriname in 1863, many former slaves moved to Paramaribo. The city's population grew rapidly, and industrial development began in the mid-1900's.

Gary Brana-Shute

Paramecium, *PAIR uh MEE shee uhm,* is a tiny one-celled organism that can hardly be seen without the microscope. This type of organism is a *protozoan.* Paramecia live in ponds and slow-moving streams.

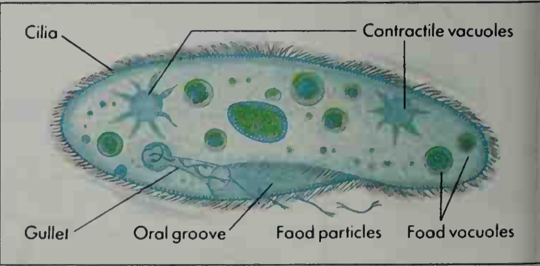
The paramecium is often compared to the *ameba,* another protozoan. Like the ameba, a paramecium is made up of watery material. The paramecium is clear on the surface and granular inside. On the inside, paramecia have one large nucleus and at least one smaller nucleus.

The paramecium has more special structures than the ameba. A stiff layer on the outside gives it a permanent shape, unlike the ameba. It looks like the bottom of a shoe. A paramecium is covered with fine hairs called *cilia.* It swims by beating its cilia. A network of fibers below the surface connects the cilia.

Food enters the paramecium through a hollow in one side called the *oral groove.* The oral groove leads to a tube called the *gullet.* Food in the gullet forms a ball which passes into the protoplasm as a food *vacuole.* The food is digested as the vacuole passes through the organism, and the waste is passed out from a special place called the *anal pore.*

Two star-shaped spots that seem to appear and disappear in the organism are the *contractile vacuoles.* They collect excess water and pass it to the outside.

Paramecia may reproduce by dividing in two across the middle. The nuclei divide, the rear half develops a new gullet, and the front half grows a new anal pore.



WORLD BOOK illustration by John F. Eggert

A paramecium is a tiny one-celled organism.

Then the paramecium breaks into two individuals. Paramecia also show the beginnings of sexual reproduction. Two individuals may come together and exchange their nuclei. This process is called *conjugation.* After conjugation, the paramecium separate and divide several times.

The paramecium shows an *avoidance behavior.* If it comes in contact with unpleasant stimuli, it reverses the movement of its cilia and backs up. Lawrence C. Wit

Scientific classification. Paramecia belong to the kingdom Protista.

See also **Protozoan.**

Paramedic, *PAIR uh MEHD ihk,* is a trained medical worker who takes the place of a physician in certain situations. Most paramedics handle routine medical duties, giving doctors more time with patients who need their expert care. Some paramedics, called *Emergency Medical Technician-Paramedics* or EMT-paramedics, give on-the-scene aid if a doctor is not immediately available. These men and women have saved many people who might otherwise have died. This article discusses EMT-paramedics. For information about other paramedics, see **Medicine** (Other careers in medicine).

Duties. Paramedics give emergency care chiefly to accident victims and to people stricken by heart attacks or other sudden illnesses. Two or more paramedics usually work together as a team called a *Mobile Intensive Care Unit* (MICU). They use a special ambulance that carries a variety of drugs and medical equipment. This equipment includes a device called a *defibrillator,* which helps correct an irregular heartbeat.

Before treating a victim, paramedics use a two-way radio to contact a physician at a nearby hospital. They report the extent of any injuries, plus such information as the victim's pulse, blood pressure, and breathing condition. For victims of a heart attack, paramedics have an instrument that can send the doctor an *electrocardiogram,* a recording that describes heart activity. Such basic information helps the doctor determine the proper treatment. In serious cases, paramedics continue to treat the victim on the way to the hospital.



David R. Frazier

A team of paramedics provides emergency medical services. Such services include treatment for shock, bleeding, and heart attacks. Special equipment monitors the victim's bodily functions and sends a record of them to a nearby hospital.

Training. People who wish to become paramedics must complete an extensive medical training program given by a hospital or college. First they learn basic life-support techniques. These include treatment of shock and bleeding and restoration of breathing. Then the students learn such advanced medical procedures as treatment for heart attacks and the use of certain drugs. Graduates of the training program are certified by a hospital as Emergency Medical Technician-Paramedics. They must get additional instruction every year.

Paramedic service was introduced in the mid-1960's in the United States. Most major cities and their metropolitan areas have paramedic programs. Paramedics also serve many rural areas. David R. Boyd

See also **Emergency Medical Services; Fire department** (Emergency rescue).

Paraná, *PAIR uh NAH* (pop. 276,160), is a river port city in east-central Argentina. It is also the capital of Entre Ríos province. Paraná lies on the east bank of the Paraná River. A tunnel links it with the city of Santa Fe on the west bank. For location, see **Argentina** (political map).

Paraná is a shipping center for grain, cattle, and sheep raised in its region. It is also an administrative, cultural, and educational center and the site of a major air force base. Cement and glass are its only important manufactured products. Many of Paraná's buildings and parks overlook the river. The Plaza San Martín, in the city's center, has many fountains and a statue of José de San Martín, who led the fight for Argentina's independence from Spain. Paraná was founded in 1588, and a Spanish mission community was established there in 1730. From 1853 to 1862, it was the capital of Argentina.

Richard W. Wilkie

Paraná River, *PAIR uh NAH,* is the second longest river in South America, with a length of 2,485 miles (3,999 kilometers). Only the Amazon River is longer. The Paraná is formed in southern Brazil, where the Rio Grande and Paranaíba rivers meet. From there it flows south through Brazil and along the boundary between Brazil and Paraguay. Then it makes a boundary between Paraguay and Argentina and travels through Argentina. It empties into the Atlantic Ocean through the estuary known as the Plata River (Río de la Plata). Ocean vessels can travel through the estuary and up the Paraná as far as Rosario, Argentina, 400 miles (640 kilometers) from the Atlantic. The Paraguay River is the main branch of the Paraná River. See also **Paraguay River; Río de la Plata.**

Gregory Knapp

Paranoia. See **Mental illness** (Personality disorders).

Paraplegia. See **Paralysis.**

Parapsychology, *PAIR uh sy KAHL uh jee,* is the scientific study of certain alleged phenomena that do not exist according to current scientific assumptions. It primarily involves the study of extrasensory perception (ESP) and psychokinesis. J. B. Rhine established the first parapsychology laboratory in the late 1920's at Duke University in Durham, North Carolina. Parapsychology is a very controversial field. James E. Alcock

See also **Extrasensory perception; Clairvoyance; Mind reading; Psychical research; Telepathy.**

Parasite, *PAIR uh syt,* is an organism that feeds and lives on another organism, called a *host.* Some author-

ities point out that all animals are parasites because they must rely on other living things for food. But in a stricter sense, parasites usually live on plants and animals bigger than they are. These organisms only feed on small amounts of the host's tissue or food at a time. They use the food to produce energy, and wastes are released directly into the host's body.

Parasites have varying effects on the body of their host. Experts believe that most parasites cause little or no harm to their host. For example, one type of ameba lives in human intestines. It feeds on partly digested food and other intestinal parasites without causing any obvious ill effects. Other types of parasites may cause great harm. For example, the *protozoans* (one-celled organisms) that cause malaria are parasites in the red blood cells of human beings.

Parasites that feed on people and animals cause many types of diseases. For example, one type of ameba destroys the lining of the intestines of human beings. This produces the painful disease called amebic dysentery. Other protozoans may invade the blood of mammals and cause diseases such as malaria and Texas cattle fever. Blood-sucking insects and ticks pick up parasites from infected animals and pass them on to other animals and human beings.

Parasitic flatworms and roundworms cause serious damage and often kill their hosts. One group of flatworms, called flukes, live in the intestines, liver, lungs, or blood of animals. Another group, the tapeworms, mature in the intestines of animals. They attach themselves to the intestinal wall with suckers or hooks. The tapeworms then absorb digested food, depriving the host of nourishment. Hookworms are the most harmful group of roundworms. They live in intestines and feed on the blood of their host.

Other parasites attack the skin. For example, parasitic fungi cause ringworm, a skin disease in human beings. Some insects, ticks, and mites feed by biting the skin of people and animals. Their bites are irritating, but the diseases these parasites spread are far more serious. Certain ticks transmit Rocky Mountain spotted fever to people. One type of mosquito spreads yellow fever and



Cath Ellis, University of Hull from Science Photo Library

A tapeworm lives in intestines of people and animals.



Centers for Disease Control

The Rocky Mountain wood tick infects humans.



Centers for Disease Control

The mite lives on various plants and animals.



Stephen J. Krasemann, Bruce Coleman Ltd.

Mistletoe is a plant parasite that grows on trees.



Centers for Disease Control

Trypanosomes live in the blood of vertebrates. Tsetse flies carry the parasite, which causes sleeping sickness.



Centers for Disease Control

The trichina worm lodges in the muscles of hogs and humans. It causes the painful disease called *trichinosis.*



Arthur M. Siegelman

Apple scab is caused by a fungal parasite. It appears as brown patches on apple blossoms, fruit, and leaves.



Arthur M. Siegelman

Downy mildew is a fungus that attacks fruit and vegetable plants. It grows from a single cell called a *spore.*



Arthur M. Siegelman

Plasmodium vivax is one of the tiny parasites which cause malaria, a serious disease of human beings.



Arthur M. Siegelman

Black stem rust is a fungus that lives part of its life on barberry plants, *above,* and part on wheat plants.

another carries malaria. The tsetse fly transmits African sleeping sickness. People may get typhus from a body louse.

Insects, ticks, and mites may be parasitic only during particular periods of life. For example, only adult fleas are parasites. Red bugs and screwworms, a type of fly, are parasites only in their *larval* (infant) stage.

Parasites that feed on plants include various types of insects, roundworms, and fungi. *Aphids* (plant lice), scale insects, and threadworms may kill their plant hosts. Parasitic fungi cause wheat and bean rust, potato and tomato blight, apple scab, and downy mildew of grapes. Experts estimate that plant parasites destroy about $3 billion worth of crops in the United States each year.

Some species of plants live as parasites on other plants. For example, the dodder plant grows on and kills alfalfa, clover, and flax. Mistletoe, a parasite of forest trees, is called a *partial parasite* because it makes some of its own food.

Most *bacteria* (one-celled organisms) are parasites. Bacterial diseases, such as tuberculosis and pneumonia, are usually considered apart from those caused by other parasites. Jacqueline R. Shepperson

Related articles in *World Book* include:

Actinomycosis	Fungi	Roundworm
Ameba	Hookworm	Rust
Aphid	Horsehair worm	Saprophyte
Bacteria	Ichneumon wasp	Schistosomiasis
Chigger	Louse	Sleeping sickness
Dodder	Malaria	Smut
Dysentery	Mildew	Symbiosis
Elephantiasis	Mistletoe	Tapeworm
Ergot	Mite	Tick
Flea	Mosquito	Trichina
Fluke	Pinworm	Yeast
Fungal disease	Rot	

Parathion. See **Insecticide** (Organic insecticides).

Parathyroid gland, *PAR uh THY royd,* consists of four tiny glands that function as one gland. These glands lie in the front of the neck close to the thyroid gland. The parathyroid glands secrete parathyroid hormone (PTH), also called *parathormone,* into the blood. PTH helps regulate the amount of calcium and phosphate in the body. These minerals are necessary for a number of important body processes, including bone growth and muscle and nerve function.

When the level of calcium in the blood becomes low, the parathyroid glands increase secretion of PTH. PTH causes the kidneys to produce urine that contains less calcium and more phosphate than normal. The urine is then expelled from the body. PTH also frees calcium and phosphate from bone. In addition, PTH increases the amount of calcium absorbed from the digestive tract.

Malfunctioning of the parathyroid glands can lead to low levels of calcium in the blood. Severe calcium deficiency results in *tetany,* a dangerous condition involving chronic muscle spasms. Charlotte H. Greene

Paratroops. See **Airborne troops.**

Paratyphoid fever. See **Typhoid fever.**

Parcel post is a postal service for carrying packages. The governments of the United States, Canada, and most other countries carry parcels as part of their regular postal services.

The United States established its parcel post service in 1913. The U.S. Postal Service divides all mail into five classes. Parcel post consists of fourth-class mail that weighs from 1 to 70 pounds (0.45 to 32 kilograms). Items mailed through parcel post also must not exceed a certain size. The size is determined by adding the length of the parcel's longest side and the distance around the parcel at its thickest part. The sum of these measurements must not exceed 108 inches (274 centimeters). Parcel post charges are based on the parcel's weight and on the distance the parcel must travel.

In the United States, almost any kind of merchandise may be mailed through parcel post, including day-old live poultry, baby alligators, and bees. However, parcel post cannot be used to send explosives, materials easily set on fire, or other merchandise that might be dangerous to handle.

Critically reviewed by the United States Postal Service

Parchment is an animal skin that has been prepared as a surface for writing. The word *parchment* usually means a writing material made from the skins of sheep, goats, or calves. Such materials are very durable. Parchment scrolls have survived from about 1500 B.C.

In making parchment, the skins are first washed and then placed in lime to remove the hair and fat. Next, the skins are stretched on a frame and thinned with knives and scrapers. Finally, the skins are rubbed with chalk and pumice in order to create a smooth, white writing surface.

A form of fine, high-quality parchment called *vellum* is made from the skins of calves, kids, or lambs. Vellum has been used for important writings such as charters, university diplomas, and wills. *Heavy parchment* is made from the skins of calves, donkeys, goats, and wolves. It is used for drumheads. *Parchment paper,* also called *vegetable parchment,* is made by dipping pure, unsized paper into a cooled mixture of sulfuric acid and water, and then washing and drying it under pressure. This process makes the paper partly transparent and much stronger than ordinary paper. Parchment paper is used for legal documents and maps.

Parchment was especially popular in the ancient cities of Asia Minor. The Jews, Persians, and other ancient peoples used it for sacred and literary writings. Beginning about 200 B.C., parchment gradually replaced papyrus as the most commonly used writing material. Parchment remained the leading writing material in the West even after the introduction of paper from the Middle East in the A.D. 1000's. Paper largely replaced parchment about the time printing was being developed in Europe during the 1400's. Parchment is still sometimes used for important documents. Paul H. Mosher

See also **Library** (Ancient libraries of animal skin); **Manuscript; Papyrus; Scroll; Book** (Early books); **Bible** (picture: Illuminations).

Pardon is the act of releasing a person from the legal penalties for a crime the person has committed. Offenders can be pardoned before or after they are convicted. Pardons are granted by chief executives, such as kings, presidents, and governors. The executive sometimes acts on recommendations made by others.

Pardons differ from paroles. Parole is a continuation of a sentence away from prison, and paroled prisoners must follow certain rules. But a person who receives a pardon is entirely free. The person is not regarded as

a criminal, because the pardon has the effect of wiping out the conviction. The pardon may also be used to free a person whose innocence is established after conviction. State governors grant many pardons to restore civil rights to offenders who have served their sentence and have been properly rehabilitated. James O. Finckenauer

See also Amnesty; Parole.

Paré, *pa RAY,* **Ambroise,** *ahm BRWAZ* (1510?-1590), a French surgeon, made important contributions to the use of surgery in medicine. Paré stopped treating gunshot and surgical wounds by pouring boiling oil over them, which was the practice at that time. Instead, he came to rely on the power of nature to heal his patients. His motto was, "I bandaged him, God healed him." In Paré's day, doctors considered surgery beneath their dignity, and most operations were performed by barber-surgeons. Paré's work helped to raise the standing of surgery.

Paré was born at Bourg-Hersent, near Laval. His formal education was sketchy, but he served as an apprentice to a barber-surgeon and learned on the battlefield as a surgeon in the French army. In 1552, Paré became surgeon to Henry II of France. He later became first surgeon to Charles IX and Henry III. Paré died on Dec. 22, 1590. Matthew Ramsey

See also Medicine (The Renaissance; picture: Surgical advances).

Parent is a father or mother. There are two types of parents, *biological parents* and *social parents.* A child's biological parents are the man and woman who physically produce the baby. They contribute the mental and physical characteristics that the child inherits. The child's social parents—who may not be the same as its biological parents—are the ones who raise the child. This article discusses social parents.

The role of parents is to provide care, love, and training for their children. Children must have years of physical care, including food, shelter, and protection from harm. Love and affection are also necessary to stimulate children to learn and grow. This love should come from a person or from people with whom the children can develop a lasting attachment. Youngsters raised in institutions who did not get enough individual attention or love often experience problems forming personal relationships later in life. They may also fail to achieve other kinds of normal growth and development, though they receive the necessary physical care.

Parents play a major role in a process called *socialization,* by which children learn to become independent members of society. For example, parents train their youngsters to speak, to dress themselves, and to perform other basic activities. Girls and boys also learn *sex roles*—that is, the roles they are expected to play as adult females or males—by identifying with the parent of the same sex.

Children are born with great individual differences in intelligence, physical ability, and temperament, and so they vary greatly in talent, personality, and other characteristics. Although parents greatly influence a child's development, they are not completely responsible for his or her strengths and weaknesses. Other influences, over which parents have little control, also affect a child's attitudes and development. These influences may include friends, teachers, and even characters on television.

Changes in parenthood have resulted from the many scientific, economic, and social changes during the last hundred years. Early American parents expected their children to contribute to family support and to perform many adult tasks by the age of 6 or 7. During the 1800's, most children became independent and self-supporting as teen-agers. Today, childhood is more prolonged and parents spend more years and more money raising their children.

People today have greater freedom than ever before in deciding whether to become parents. Modern birth control methods allow couples to choose how many children, if any, they wish to have and when to have them. Also, scientists have developed techniques that permit women beyond the traditional childbearing age to bear children.

Another change is that greater numbers of women have entered the work force. Today, most American mothers with school-age youngsters work outside the home. The traditional division of tasks between parents has changed. Many fathers are now more active in the care of children and the home.

Children today are dependent upon their parents' care for a longer time, but many mothers are seeking to expand their role beyond that of a parent. As a result, there is a shortage of child care. Day-care programs provide one solution (see Day care).

In the past, young parents got help and instruction in child rearing from their own parents or other relatives. Today, less than 5 percent of the families in the United States have an extra adult who shares parental responsibility. This lack of help, plus the increased duration of obligations to children, has created a need for information about raising children. The need accounts for the popularity of child-care books and *parent education* groups or courses. Robert H. Abramovitz

Related articles in *World Book* include:

Adoption	Parent education
Baby	Parents Without Partners
Child (The role of parents)	Reproduction, Human
Family	Socialization
Foster care	Women's movements (Impact of women's movements)
Guardian	

Additional resources

Koman, Aleta, and Myers, Edward. *The Parenting Survival Kit.* Perigee, 2000.
Ryan, Elizabeth A. *Straight Talk About Parents.* Facts on File, 198[illegible]
Unell, Barbara C., and Wyckoff, J. L. *The 8 Seasons of Parenthood* Times Bks., 2000.

Parent education helps parents or future parents to acquire the practical and emotional skills needed to raise children. Mothers and fathers develop some of these skills informally, by recalling how they themselves were brought up and by trial and error. They also learn by watching other parents and by sharing experiences and ideas with them. However, almost all parents find that raising children is more challenging than they expected it to be. As a result, many parents supplement informal learning with formal activities specifically designed to teach skills of parenthood. This article discusses the type of formal parent education that is offered by schools, social service agencies, churches, and other organizations.

Changing family life contributed to rapid growth of parent education programs during the late 1900's. The

traditional American family once consisted of a working father, a mother who did not work outside the home, and their children. New parents were likely to live near their own parents, who helped with child care and provided advice and support. Today, many young mothers and fathers live far away from their own parents. Both parents in two-parent families often work outside the home, and many other families are headed by a single working parent. In addition, growing numbers of unmarried pregnant teen-agers keep and raise their babies.

These new patterns may increase stress and loneliness for parents and dull their pleasure in raising children. In severe cases, pressure and isolation can lead parents to abuse drugs or alcohol or to neglect or abuse their children. Parent education programs help mothers and fathers cope with a wide range of challenges, from minor frustrations to major hardships.

Methods of parent education

Parent education may be organized in different ways. Some groups consist of parents who have children of similar ages. Another type is made up of parents who share a common experience, such as having been abused themselves as children. A third type brings together parents who want to learn a skill, such as giving children a voice in family decisions. Methods of parent education include (1) media-based education, (2) study groups, (3) observation and participation, (4) home visitation, and (5) group training.

Media-based education reaches people through books, magazines, newspapers, television, radio, computers, and other sources. Many how-to books provide parenting advice. Magazines, newspapers, TV, and radio cover many topics of interest to fathers and mothers. Computers also offer a wide variety of resources, including access to the worldwide information network called the Internet.

Study groups meet to explore approaches to raising children. Some groups focus on one particular method. Others investigate a wide range of topics and theories. Study groups enable parents to talk with others who have similar situations and to learn from one another. Many such groups teach parents strategies for understanding relationships within families. Parents also learn to express themselves effectively and to listen carefully to each other and to their children.

Observation and participation take place in a classroom or other instructional setting. An expert demonstrates various techniques for mothers or fathers. The parents then practice their newly learned skills with their children while the expert supervises their efforts.

Home visitation helps parents encourage their children's development. Experts known as *home visitors* call on parents and show them how to use books, toys, and everyday activities to teach ideas and skills. The visitors may also leave educational materials for the family to use until the next visit. Home visitation tailors parent instruction to the particular needs of each father, mother, and child.

Group training, like home visitation, focuses on preparing parents to teach their children. The parents work in groups, however, rather than individually with a home visitor.

Family support programs

Family support programs, also called *family resource programs,* provide child-rearing education and extensive assistance to families of young children. These community-based programs are designed to provide the greatest possible opportunity for each child's growth and development. Family support programs may offer counseling and telephone call-in services that provide information, advice, or crisis assistance. The programs also encourage exchange of information among parents to build informal support networks. Family support programs put parents in contact with agencies and organizations that can assist them in raising their children. The programs match the type and amount of support to each family's needs. Many states have passed laws to establish these programs in schools, hospitals, and community service agencies.

History

The parent education movement in the United States began during the late 1800's and early 1900's. Many organizations concerned with parenthood were established during this period, including the National Congress of Mothers, which is now the National Congress of Parents and Teachers (National PTA).

The government also became active in helping parents during this period. In 1912, for example, a federal agency called the Children's Bureau was established. It distributed information on child development and published popular pamphlets, including *Infant Care* and *Your Child from One to Six.* The Smith-Lever Act of 1914 set up what is now the Cooperative Extension System, which provides advice about child care.

The 1920's marked the beginning of scientific study of child development. Many universities established child study centers, where researchers investigated the growth and development of children and applied their findings to educational methods.

Parent education has expanded greatly since 1960, partly because of increased government support. In 1965, for example, a federal project called Head Start was set up to help low-income parents prepare their children for school (see **Head Start**). Education for Parenthood, another federal government project, helps schools develop courses for teen-agers.

Mary Renck Jalongo

See also **Parent** with its list of *Related articles.*

Additional resources

Biederman, Jerry and Lorin, eds. *Parent School: Simple Lessons from the Leading Experts on Being a Mom and Dad.* M. Evans & Co., 2001.

Franck, Irene M., and Brownstone, D. M. *Parenting A to Z.* HarperCollins, 1996.

Parent-teacher organizations are volunteer groups that work in communities to improve the education, health, and safety of children and youth. To achieve these goals, these organizations encourage close cooperation between home and school. Parent-Teacher Associations, abbreviated PTA's, are among the best known and most active of these groups in the United States. Other parent-teacher organizations include Home and School Associations, various local parent advisory committees, and school-based councils.

Parent-Teacher Associations

PTA's are associated with the National Congress of Parents and Teachers. These local associations also work with their state branch of the national organization. Most local PTA's function in public and private schools at the elementary, junior high, and high school levels.

Each local PTA draws up its own constitution, using the rules of the National Congress as guidelines. The constitution outlines the local unit's specific purposes, procedures for holding meetings and planning programs, and rules for electing officers.

Membership in a PTA is open to anyone who wishes to help the organization achieve its objectives. A person who joins a local PTA automatically becomes a member of the state and national organizations as well.

Purpose. Each local PTA unit develops programs to suit the needs of its school and community and to fit the basic goals of the National Congress of Parents and Teachers. These goals, called *Objects,* of the National Congress urge cooperation between parents and educators to give students all possible advantages in mental and physical education. The Objects also call for improvement of the environment of children and youth in their home, school, and community. See **National Congress of Parents and Teachers**.

Activities and programs. Most PTA's hold meetings regularly during the school year. These sessions bring parents and other citizens into schools to learn about courses of study and teaching methods.

Most meetings include open discussions of the needs and problems of the school and the community. These discussions may lead to such organized efforts as campaigns to obtain new classroom equipment, build additional playgrounds, or improve traffic safety. In some cases, the National Congress gives information and materials to local PTA associations to carry out projects.

Local PTA's organize field trips, set up tutoring programs in arithmetic and reading, and conduct health examinations. They also develop study-discussion groups in family life and other areas of parent education. Many local PTA units sponsor programs dealing with such matters as career and employment opportunities, delinquency, drug abuse, and intercultural understanding.

PTA's often work with other community service organizations, including the American Legion, Boy and Girl Scouts, and the Neighborhood Youth Corps. Many PTA's, together with such community groups, have worked for Head Start, a program of education and health for economically deprived preschool children. PTA members also have helped provide books for small, poorly equipped schools in Appalachia, an economically depressed region in the eastern United States.

Parent-Teacher-Student Associations (PTSA's), like PTA's, are associated with the National Congress of Parents and Teachers. Most PTSA's began as local PTA units in high schools. They expanded to include students, so that the young people could take an active role.

PTSA's give students a role in planning the educational programs of public and private high schools. Some PTSA's have helped develop new methods of instruction that provide greater opportunities for self-directed learning and independent study. Other PTSA's have encouraged student governments to become more active. PTSA's also work to include parents and children from all cultural, ethnic, and economic groups in school activities.

Other parent-teacher organizations

Home and School Associations are parent-teacher organizations that function chiefly in Roman Catholic schools. They promote a close working relationship between parents and teachers to further the goals of Catholic education. Home and School Associations also encourage parents to take an active interest in neighborhood conditions that influence children's behavior. The associations try to improve their communities to help solve behavior problems among young people. Many local Home and School Associations cooperate with other community groups in promoting the care and protection of children and youth.

Home and School Associations develop their programs through committees and projects at the national, regional, and community levels. Most local associations operate in individual *parishes* (church districts). Several parishes also may combine to form an association.

Various public schools and non-Catholic private schools also have parent-teacher groups called Home and School Associations. The goals and services of these groups resemble those of the associations that function in Roman Catholic schools.

Local parent advisory committees have been formed in a number of public and private schools throughout the United States. Many of them assist in government-sponsored education programs for the children of underprivileged families. The federal Elementary and Secondary Education Act of 1965 requires officials of local schools to permit parents to take a direct part in planning and operating such programs. Parent advisory committees also help school administrators carry out programs that meet the educational needs of children at various schools.

School-based councils have been established through legislation in several states. These councils are formed by individual schools and include parents, teachers, and other community members. A school-based council helps a principal make improvements in a school. Stephen M. Fain

Parents Without Partners is an organization of men and women who are raising children in a home that has only one parent. These parents may be divorced, separated, or widowed, or they may never have been married. The organization works to help its members and their children build satisfying lives in a society in which most homes have two parents.

Local chapters of Parents Without Partners are in the United States, Canada, and four other countries. The chapters sponsor discussions and speakers, as well as family recreational activities. Teen-agers may have their own chapters.

Parents Without Partners publishes a magazine, *The Single Parent,* and maintains a library of publications and tapes dealing with the problems of single parenthood. The organization works for better laws for single-parent families. It sponsors conventions, seminars, and other meetings. Parents Without Partners was founded in 1957 and has headquarters in Boca Raton, Florida.

Critically reviewed by Parents Without Partners, Inc.

Pareto, *pah REH toh,* **Vilfredo,** *veel FRAY doh* (1848-1923), was an Italian sociologist and economist known chiefly for his theories on political behavior. He believed that people base political decisions and all other actions on emotion, instinct, and similar drives—rather than reason. He also maintained that all societies are governed by a small group of rulers called an *elite.* According to Pareto, the elite is continually overthrown and replaced by people from the lower ranks, who become the new elite. He called this process the *circulation of elites.*

In economics, Pareto theorized that the amount of consumer satisfaction with a product cannot be measured. However, consumers can rank products in order of preference, unless they are indifferent about which of two or more products they buy. This idea led to the development of *indifference analysis,* a method of studying consumer behavior. Pareto also developed new ways to apply mathematics to economic problems.

Pareto was born on July 15, 1848, in Paris. He worked as a civil engineer before taking up sociology and economics. Pareto's books include *A Manual of Political Economy* (1906) and *The Mind and Society* (1916). He died on Aug. 19, 1923. Irving M. Zeitlin

Paretsky, Sara (1947-), an American author of detective stories, is the creator of the female private investigator V. I. Warshawski. The success of the Warshawski series is credited with helping to break down barriers to realistic portrayals of female detectives in fiction.

Paretsky was born on June 8, 1947, in Ames, Iowa. She worked for a research company in Chicago from 1971 to 1974. After three years as a free-lance writer, she worked for a Chicago insurance company from 1977 to 1986, when she decided to become a full-time writer. Paretsky received M.B.A. and Ph.D. degrees from the University of Chicago in 1977.

Paretsky introduced the Warshawski character in *Indemnity Only* (1982). Warshawski is tough, independent, and resourceful. She has strong sympathies for people victimized by the rich and powerful. Paretsky sets her Warshawski novels in Chicago. Most of her stories involve the city's working-class neighborhoods as well as corporate and political corruption.

In 1986, Paretsky helped found Sisters in Crime. The organization promotes women writers of detective fiction and tries to improve the image of women in detective stories. Paretsky also writes short stories and articles and has edited a number of anthologies of detective stories written by women. Jon L. Breen

Paricutín, *puh REE kuh TEEN,* is the most recent volcano to form in the Western Hemisphere. It stands near the city of Uruapan in southwestern Mexico (see **Mexico** (terrain map)). It was named for the village of Paricutín, which was destroyed by the volcano.

The volcano appeared in a cornfield on Feb. 20, 1943, from a crack in the earth. Volcanic material began to erupt from the crack and formed a cone around the opening in the earth. By the end of one week, the cone stood about 450 feet (140 meters) high. In two months, it reached about 1,000 feet (300 meters).

Paricutín's lava destroyed the villages of Paricutín and San Juan Parangaricútiru and damaged nine other villages. It also turned an area of farmland and forests into wasteland before it appeared to cease activity in 1952.

Today, Paricutín stands 1,345 feet (410 meters) above its base and 9,213 feet (2,808 meters) above sea level. Lava from Paricutín covers about 9 square miles (24 square kilometers), and volcanic ash and sand extend over 19 square miles (50 square kilometers). Paricutín, like many other volcanoes in southern Mexico, is part of the *Volcanic Axis,* also called the *Transversal.* The Volcanic Axis is a line of volcanoes that extends across Mexico in an east-west direction. Katharine V. Cashman

See also **Volcano** (picture).

Paris, in Greek mythology, was a son of Priam, king of Troy. Paris's mother, Hecuba, dreamed that her unborn son was a torch that set the country on fire. A soothsayer said the dream meant the child would cause the destruction of Troy. Priam gave Paris to a slave and ordered him to kill the child. The slave left him to die, but a shepherd saved him and raised him as his own son. Paris married the nymph Oenone.

One day, messengers came from Priam to take a bull as a prize for a wrestling contest. They took Paris's favorite bull, so he entered the contest and won it back. His sister Cassandra recognized him, and Priam accepted him, disregarding Hecuba's dream.

Zeus, the king of the gods, had Paris judge a contest among three goddesses—Aphrodite, Athena, and Hera—over the Apple of Discord. This apple bore the words "To the fairest." Aphrodite promised Paris the most beautiful woman in the world, and so he chose her over the other goddesses. Hera and Athena hated him and Troy after that.

Paris fell in love with Helen, the beautiful wife of Menelaus, and took her to Troy. Menelaus was the king of Sparta, in Greece. Agamemnon, Menelaus's brother, led the Greeks in the Trojan War to get Helen back. Late in the war, Paris killed the Greek hero Achilles with a bow and arrow, but was himself later killed by the Greek archer Philoctetes. Cynthia W. Shelmerdine

See also **Helen of Troy; Trojan War; Troy** (The legendary Troy).



Otto Done, Shostal

Paricutín is the most recently formed volcano in the Western Hemisphere. It appeared in 1943 when lava began to erupt from a crack in a Mexican cornfield. It apparently ceased activity in 1952, after having formed a cone 1,345 feet (410 meters) high.



© Gerard Halary, Shosta

The heart of Paris includes many beautiful buildings that are hundreds of years old. The Seine River flows around the île de la Cité (Island of the City), *right.* The magnificent Cathedral of Notre Dame towers above the other buildings on the island.

Paris

Paris is the capital and largest city of France. It is one of the most beautiful cities in the world. Lovely gardens and parks and historic squares lie throughout Paris, and chestnut trees line the city's famous avenues. At night, floodlights shine on Paris's many magnificent palaces and monuments. The gleaming beauty of Paris has given it the nickname *City of Light.*

Every year, more than 2 million tourists visit Paris. The most popular attraction is the Eiffel Tower. This huge structure is known throughout the world as the symbol of Paris. Tourists flock to the Louvre, one of the world's largest art museums, and visit the soaring Cathedral of Notre Dame. Paris is also famous for its many restaurants, sidewalk cafes, theaters, and nightclubs.

Paris has long been a world center of the arts and education. For hundreds of years, important styles in painting and literature have developed there. About two-thirds of France's artists and writers live in Paris. The University of Paris, one of the largest universities in the world, is more than 800 years old.

The Paris area is also a great industrial center. About a fourth of France's labor force lives in the crowded area. Factories in and near Paris turn out a wide variety of products, including most of France's automobiles. Paris is known for such luxury products as expensive jewelry, perfume, and women's high-fashion clothing. Famous designers of women's clothing create Paris fashions that are copied in many other countries.

The history of Paris goes back more than 2,000 years. In 52 B.C., soldiers of ancient Rome found in the area a

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Facts in brief

Population: city, 2,147,857; metropolitan area, 9,644,507.
Area: city, 41 mi² (105 km²); metropolitan area, 185 mi² (479 km²).
Altitude: 250 ft (76 m) above sea level.
Climate: *Average temperature*—January, 28 °F (−2 °C); July, 68 °F (20 °C). *Average annual precipitation* (rainfall, melted snow, and other forms of moisture)—22 in (56 cm). For the monthly weather in Paris, see **France** (Climate).
Government: *Chief executive*—mayor (six-year term). *Legislature*—city council of 109 members (six-year terms).
Founded: 52 B.C.



Owen Franken, Stock, Boston



© P. S. Pavlovsky, Photo Researchers

The sights of Paris include the famous Eiffel Tower and sidewalk cafes. The Eiffel Tower rises 984 feet (300 meters) in the Champ de Mars, a popular park. People enjoy stopping at sidewalk cafes to eat and drink, as well as to observe life around them.

tribe of people who lived by fishing. The Romans established a colony there. During the Middle Ages, Paris grew rapidly and became a major center of culture and government. In Paris, in 1792—during the French Revolution—France became one of the first nations to overthrow its king and set up a republic. In World War I (1914-1918), Paris cabdrivers helped win the First Battle of the Marne by speeding French troops to the front in their taxicabs. German forces occupied Paris during World War II (1939-1945).

More than 2,000 years ago, the Roman general Julius Caesar described the people of what is now Paris as "clever, inventive, and given to quarreling among themselves." This description is still considered true today. Parisians are known for their creative arts and crafts, and their strong political feelings lead to many bitter quarrels. The similarities among Parisians through thousands of years help prove a French saying: "The more things change, the more they stay the same."

Today, dramatic changes are taking place in Paris. Modern office and housing complexes are being constructed in the city, along with new cultural and recreational structures. At the same time, its beautiful old buildings and monuments are being restored. Paris is staying young while preserving the treasures of its past.

The city

Paris lies 107 miles (172 kilometers) southeast of the English Channel. It is in the heart of a fertile, heavily populated lowland called the Paris Basin. Paris has a population of about 2,150,000 and is one of the world's most crowded cities. It has an average of 52,000 people per

Paris

Park or forest

City boundary
Department boundary
Expressway
Other road or street
Railroad
Point of interest





WORLD BOOK maps

square mile (20,500 per square kilometer).

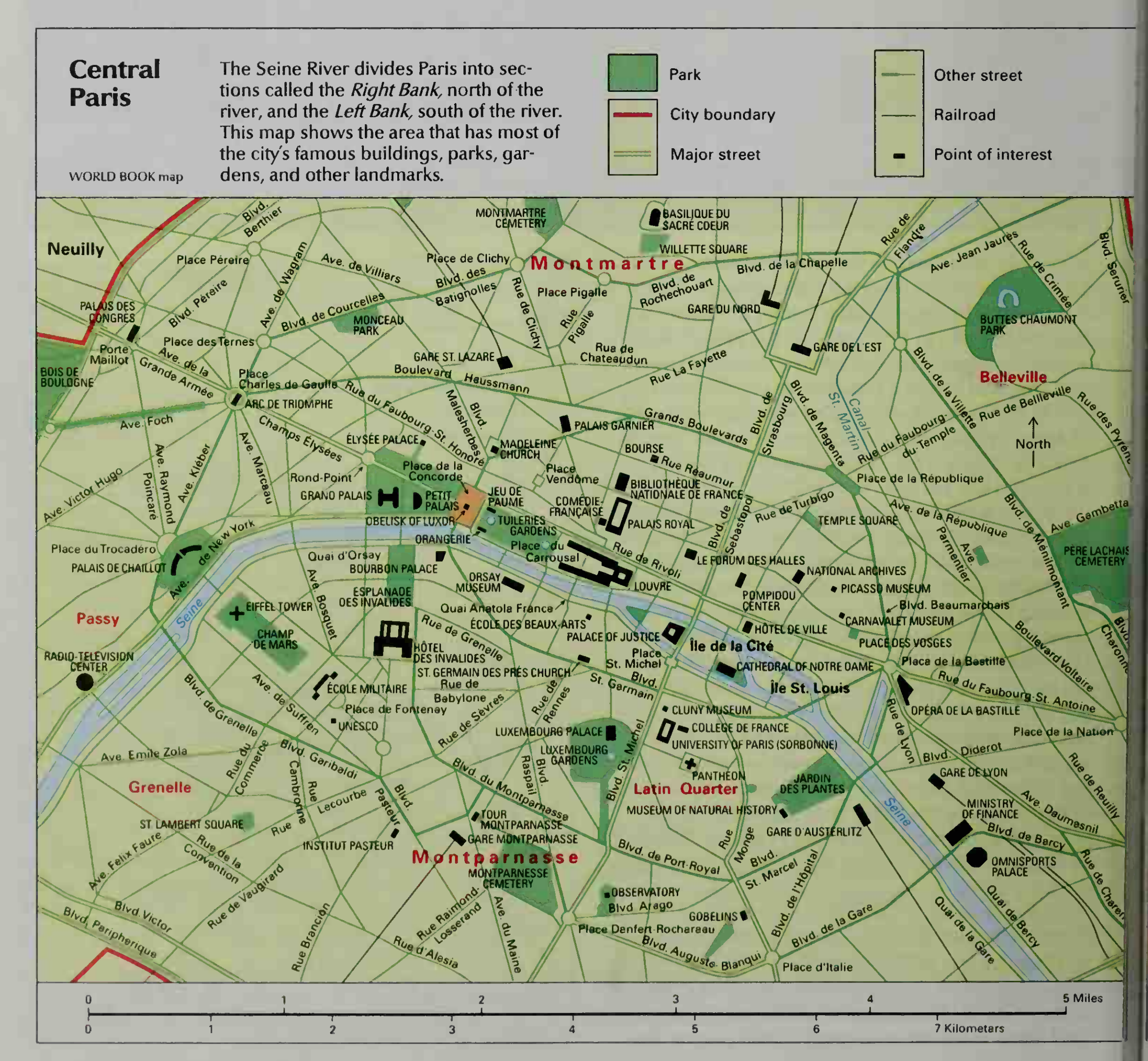
The Seine River curves through Paris for about 8 miles (13 kilometers) from east to west. The section of Paris north of the river is called the Right Bank. Busy offices, small factories, and fashionable shops are on the Right Bank. The Left Bank, south of the Seine, is a famous center of artist and student life.

Paris is laid out according to plans that developed through hundreds of years. An island in the Seine, the île de la Cité (Island of the City), is the heart of Paris. The city was founded on this island more than 2,000 years ago. Paris soon spread out on both banks of the river. About 1200, a fortified wall was built around the city. Paris continued to grow, and new walls were built in a series of widening circles. Today, there are boulevards where the walls once stood.

Gardens, squares, and parks. Paris has been described as being like a woman with flowers in her hair. This description comes from the many beautiful gardens and parks throughout the city. The Tuileries Gardens, on the Right Bank, are one of the finest formal French gardens. Neat flower beds and beautiful statues line a long path through the Tuileries. Children sail toy boats in two round fountains along the broad path. They also sail boats in the central pool of the Luxembourg Gardens, on the Left Bank. See **Tuileries.**

The Champs Élysées (Elysian Fields) is Paris's most famous avenue. It is lined with beautiful gardens and rows of chestnut trees. Along its route is the Rond-Point. This landscaped circle has magnificent fountains, and formal flower beds trimmed to look like a huge bouquet. At the western end of the Champs Élysées stands the Arc de Triomphe (Arch of Triumph). Emperor Napoleon I started to build this huge stone arch as a monument to his troops in 1806. It was completed in 1836. The arch rises in the Place Charles de Gaulle (formerly the Place de l'étoile), one of more than 130 public squares in Paris. Broad avenues extend from the square in 12 directions. See **Arc de Triomphe.**

At the eastern end of the Champs Élysées is the Place de la Concorde (Square of Peace). This square was built during the 1700's. Within it are eight huge statues, two fountains, and the Obelisk of Luxor, a stone pillar from Egypt. The Obelisk of Luxor stands 75 feet (23 meters)





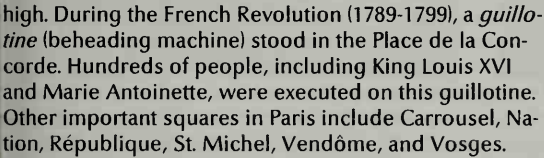
Owen Franken, Stock, Boston

The Arc de Triomphe is an impressive monument at the western end of the Champs Élysées, Paris' best-known avenue. Napoleon I ordered its construction to honor his military victories.



© Milt and Joan Mann

The Place de la Concorde stands at the eastern end of the Champs Élysées. It features fountains, statues, and an Egyptian pillar called the Obelisk of Luxor.



high. During the French Revolution (1789-1799), a *guillotine* (beheading machine) stood in the Place de la Concorde. Hundreds of people, including King Louis XVI and Marie Antoinette, were executed on this guillotine. Other important squares in Paris include Carrousel, Nation, République, St. Michel, Vendôme, and Vosges.

The Champ de Mars (Field of Mars) is a beautiful park that was once a military training ground. Among its gardens and treelined lawns are many attractions for children, including miniature automobile speedways, merry-go-rounds, and donkey rides. In the Champ de Mars stands the Eiffel Tower. This world-famous symbol of Paris rises 984 feet (300 meters). Visitors can dine in restaurants on various platforms in the tower and enjoy spectacular views of Paris. See **Eiffel Tower**.

Paris' largest parks are the Bois de Boulogne (Forest of Boulogne) and the Bois de Vincennes (Forest of Vincennes). These parks have several lakes for boating, horse-racing tracks, restaurants, theaters, and zoos.

Famous buildings. The Louvre Palace, one of the largest palaces in the world, extends $\frac{1}{2}$ mile (0.8 kilometer) along the Seine. The palace houses the Louvre Museum, one of the world's largest art museums. The Louvre dates from about 1200, when it was built as a royal fort. It was rebuilt during the 1500's as the royal palace. From then on, many French rulers expanded the Louvre. Napoleon III began to build the last addition in 1852. From 1984 to 1989, the Louvre's exhibition space was restored and enlarged, and a modern glass pyramid entrance was built in the courtyard. The modern entrance contrasts sharply with the traditional architecture of the Louvre building itself. See **Louvre**.

A number of historic buildings of Paris house government offices. The main house of France's Parliament, the National Assembly, meets in the Bourbon Palace, completed in 1728. The Luxembourg Palace is the meeting place of the Senate, the less powerful house of France's Parliament. The palace was built during the early 1600's.

© Milt and Joan Mann



Luxembourg Gardens provide Parisians and visitors with a quiet, scenic resting place in the busy Left Bank area. The landscaped grounds include rows of colorful flowers. Luxembourg Palace, *background,* overlooks Luxembourg Gardens. It dates from the early 1600's.

The president of France lives in the Élysée Palace, built in 1718. The Palace of Justice stands where the ancient Roman governors and early French kings lived on the Île de la Cité. Today, high French courts meet there. The Hôtel de Ville (City Hall) stands where Paris' first town hall was built in 1357.

The domed Panthéon is a monument to French heroes and other famous people. It was originally a church named for Sainte Geneviève, the patron saint of Paris. In A.D. 451, she organized the city's defenses against a threatened attack by Attila the Hun. It is believed that her prayers prevented the attack and saved the city. In 1791, the church was named the Panthéon, and became a burial place. Jean Moulin, a hero of World War II, was buried there in 1965. After German troops occupied France in 1940, Moulin organized forces to fight them. The Germans captured Moulin and tortured him to make him name his friends. Moulin tried to kill himself so he would not weaken and betray them. He later died from the torture.

The Cathedral of Notre Dame, the most famous of Paris' many beautiful churches, stands on the Île de la Cité. The cathedral was completed in the mid-1200's, and is known for its majesty and stone carvings (see **Notre Dame, Cathedral of**). Many Roman Catholic pilgrims visit the Basilique du Sacré Coeur (Basilica of the Sacred Heart). This basilica, with its huge bell tower and onion-shaped dome, is one of the city's most familiar sights. The gleaming white church rises atop Montmartre, Paris' tallest hill at 423 feet (129 meters) high.

Arts. Paris has long been famous as a world center of the arts. Thousands of actors, musicians, painters, and writers work or study there. Many of them live in the Montmartre district. They come from all parts of France and from many other countries. They are attracted by Paris' special atmosphere of freedom in the arts, in which new styles can develop. Painters and sculptors show their work at exhibitions called *salons,* and in the city's many art galleries. Outstanding painters and sculptors who lived in Paris include Georges Braque, Pablo Picasso, Pierre Auguste Renoir, and Auguste Rodin. Famous novelists and playwrights who lived in Paris include Albert Camus, André Gide, Victor Hugo, Marcel Proust, and Jean-Paul Sartre.

Paris has about 60 theaters. The Comédie-Française, Paris' most famous theater, offers classics of French drama. The Opéra de la Bastille presents opera. The Palais Garnier, which formerly housed the opera and was generally called the Opéra, holds dance programs. Paris also has several symphony orchestras.

Museums and art galleries of Paris are storehouses of many priceless art treasures. The works of painters and sculptors of the late 1800's and the 1900's are displayed in the National Museum of Modern Art in the Georges Pompidou National Center of Art and Culture. The Pompidou Center also houses a public library and music and industrial design centers. The famous Louvre museum displays works considered to be of lasting greatness. It houses such masterpieces as Leonardo da Vinci's *Mona Lisa* and the Greek statue *Venus de Milo.* The huge Louvre building also houses the Museum of Decorative Art. This smaller museum has a fine collection of antique French furniture. The Picasso Museum, originally a mansion built in the 1600's, exhibits many of



© Milt and Juan Mann

The Venus de Milo is one of the many art treasures in the Louvre, one of the world's largest art museums. The Louvre has about 8 miles (13 kilometers) of galleries.

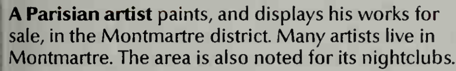


© Eric Brissaud, Gamma/Liaiso

The Opéra de la Bastille, which opened in 1990, is one of the largest and most technically advanced opera houses in the world. It is located in the historic Place de la Bastille.



© Susan McCartney, Photo Researchers



A Parisian artist paints, and displays his works for sale, in the Montmartre district. Many artists live in Montmartre. The area is also noted for its nightclubs.



Owen Franken, Stock, Boston

The Pompidou Center is famous for its extremely modern design. The building's structural elements are visible from the outside. It houses artworks and also includes a library and music and industrial design centers.

Pablo Picasso's works and paintings that the Spanish artist collected. The Museé d'Orsay houses works of art from the 1800's, especially impressionist paintings. The museum is a converted railroad station built in 1900. The Orangerie and the Jeu de Paume museums stand across from one another on the Place de la Concorde at the end of the Tuileries Gardens. The Orangerie's collection includes European paintings of the late 1800's and early 1900's. The Jeu de Paume displays contemporary art.

The Army Museum is one of the world's largest military museums. It has outstanding collections of historical weapons and armor. Nearby is the tomb of Napoleon I. The museum and tomb stand on the grounds of the Hôtel des Invalides (Home for Disabled Soldiers), completed in 1676. The Cluny Museum, a house built in the 1400's, has artworks and other objects of the Middle Ages. The Carnavalet Museum, a house dating from the 1500's, has displays that tell the history of Paris.

Schools and libraries. The University of Paris dates from the 1100's. It developed in an area on the Left Bank that has been called the Latin Quarter since the Middle Ages. At that time, the students and teachers who lived there spoke to one another in Latin. Today, the university has 13 units in the city and its suburbs (see **Paris, University of**). The world-famous École des Beaux-Arts (School of Fine Arts) offers courses in drawing, engraving, painting, and similar subjects (see **École des Beaux-Arts**). Other educational institutions in Paris include the College of France and the Polytechnical School.

The Bibliothèque Nationale de France, France's national library, is one of the largest libraries in Europe (see **Bibliothèque Nationale de France**). Other important Paris libraries include the Mazarine Library of the Institute of France, the nation's major learned society, and libraries of the University of Paris.

Economy. Paris is the chief financial, marketing, and distribution center of France. Many company headquarters and banks and other financial institutions operate in the city. Over half the nation's business is done in Paris. Jobs provided by the national and local governments contribute greatly to the city's economy. Paris and its surrounding area make up the country's major manufacturing center. The Paris region is the center of the great French automobile industry. Other important Paris industries include book publishing and the manufacture of chemicals, dyes, electronic machinery, furniture, leather goods, and railroad and airplane equipment. Paris has long been a world center of such luxury goods as expensive jewelry, perfume, and women's high-fashion clothing. These famous *articles de Paris* are produced in many small plants in the heart of the city. They are sold in fashionable shops on the Right Bank.

Paris is the transportation center of France. The national railroad network forms a cobweb pattern, with most lines extending from Paris in all directions. Three major airports serve Paris—Charles de Gaulle, Le Bourget, and Orly. The Paris subway, called the Métro, has more than 100 miles (160 kilometers) of track. The Regional Express Network is a suburban commuter train system that links Paris with its suburbs. The trains travel at about 60 miles (96 kilometers) per hour.

Paris has about 10 daily newspapers. They account for about a third of the circulation of all French dailies. The largest Paris paper, *France-Soir,* has a daily circulation



La Défense—a building complex with apartments, offices, and other facilities—stands on the western outskirts of Paris. Modern sculptures, as well as trees and fountains, decorate the complex's large pedestrian mall. La Défense has some of the tallest buildings in the Paris area.

© Robert Clark, Photo Researchers

of more than 800,000 copies. *Le Monde,* another Paris paper, is world famous. Six major television networks and nine radio networks also operate from Paris. Almost half of them are government-owned.

Government. A mayor serves as the head of government. A city council makes the city's laws. The 109 council members are elected by the people to six-year terms. The council members elect the mayor to a six-year term. Paris is divided into 20 local government units called *arrondissements* (wards or districts). A commission handles the government affairs of each *arrondissement.*

From the 1870's until 1977, prefects appointed by the national government headed the government of Paris. In 1977, a mayor became the head of government.

History

Early years. In ancient times, a Celtic tribe called the Parisii lived in what is now Paris. The Parisii occupied an island in the Seine River. The island is now called the île de la Cité. In 52 B.C., Roman invaders established a colony there and called it Lutetia. The town soon spread out on both banks of the river. It became known as Paris about A.D. 300.

Clovis, the first ruler of the great Frankish kingdom, made Paris his capital in 507. Hugh Capet, the count of Paris and duke of the surrounding region, became king of France in 987. As the French kings gained power, the capital grew in importance and population. Philip II, who ruled from 1180 to 1223, developed Paris as a center of culture, government, and learning.

The Renaissance. The French kings further developed the culture and beauty of Paris during the Renaissance, a revival of art and learning that lasted from the 1300's to the 1500's. The people they hired to design the new boulevards, palaces, and squares looked to ancient Greece and Rome for models. The Louvre, a fortress dating from about 1200, was rebuilt as the royal palace during the 1500's. Many French rulers later built additions to the Louvre and made it the largest palace in the world. Paris was the center of the bloody French Revolution (1789-1799). See **French Revolution.**

The Napoleonic era. During the early 1800's, Napoleon Bonaparte built many new buildings, laid out public gardens, and made other improvements in Paris. Napoleon III, emperor from 1852 to 1870, did much to give Paris its present appearance. He built banks, hospitals, railroad stations, theaters, and wide avenues.

Paris in wartime. In the Franco-Prussian War (1870-1871), Paris surrendered to Prussian troops after a hard siege in which the city's food supplies were cut off. The starving Parisians ate cats, dogs, and rats to stay alive. See **Franco-Prussian War.**

The Germans did some damage to Paris with long-range guns in World War I (1914-1918) but did not capture the city. In September 1914, the Germans pushed French troops back to the Marne River, about 15 miles (24 kilometers) from Paris. The French held their ground, and taxicabs from Paris brought out fresh troops. This "taxicab army" helped win the First Battle of the Marne, which ended Germany's chances for a quick victory.

German troops occupied Paris during World War II (1939-1945). They broke through the French defenses in June 1940 and pushed quickly to Paris. To save Paris from destruction, the French government declared it an *open city,* an undefended city opened to the enemy. German troops entered Paris without a fight and marched triumphantly down the Champs Élysées. Paris became a center of French underground resistance. In mid-1944, Allied troops began driving the Germans from France. The Allies freed Paris in August 1944.

Renewal and new construction. In 1960, a vast renewal program was drawn up, scheduled for completion in 2000. Old buildings and other facilities that would not be able to serve the future population were scheduled to be replaced. Old monuments, palaces, and other buildings valuable for their beauty began to be restored. A 1961 amendment required all building owners to sandblast and wash the front of their property. By the mid-1960's, Paris was a gleaming city. Since then, many buildings have been classified as historic monuments,

including all those in the historic Marais district of the Right Bank. It is against the law to alter the exterior appearance of these buildings.

During the 1960's, much new construction was started throughout Paris. Many new high-rise buildings went up. The 58-story Maine-Montparnasse Tower, France's tallest building, was completed in 1973. But many people believed the construction of high-rise buildings detracted from the city's charm. In 1973, the city council passed a 10-story height limit on new buildings in the heart of the city. High-rise construction shifted to the outskirts of the Paris area.

One of the old facilities removed from Paris was Les Halles, the city's central food market. Its narrow streets and old buildings, in which about 30,000 people worked, could no longer serve the city. In addition, movement to and from Les Halles tied up traffic. The removal was completed in 1974. Most marketing operations were transferred to a wholesale operation at Rungis, a suburb south of Paris. Les Halles was replaced with a shopping and cultural center called Le Forum des Halles. Four of its five levels are belowground.

By the early 1970's, a new 22-mile (35-kilometer) expressway around Paris had been completed. A north-south expressway opened in 1974, and an east-west expressway was completed in late 1976.

A huge, futuristic complex called La Défense opened in 1978 in the western outskirts. It houses offices, shops, entertainment and sports facilities, and apartments. The Arch of La Défense, the centerpiece of the complex, opened in 1989. Another complex, known as La Villette, is located on the northern outskirts of Paris. A museum called the Science and Industry Center, an exhibition hall, and part of a park opened there in the 1980's. A music conservatory was completed there in 1990. Also in 1990, Paris began a renovation of the city's many bridges. A theme park called Disneyland Paris opened in 1992 in the Paris suburb of Marne-la-Vallée, and a second park called Walt Disney Studios opened there in 2002.

Recent developments. By the end of the 1900's, most projects in the vast 1960 renewal plan had been completed as scheduled for 2000. The city took steps to limit air pollution, including placing limits on automobile traffic in Paris. William M. Reddy

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France (pictures)
French Revolution
July Revolution (picture)
Louvre
Notre Dame, Cathedral of
Obelisk
Paris, University of
Seine River
Sorbonne
Tuileries

Outline

I. The city
A. Gardens, squares, and parks
B. Famous buildings
C. Arts
D. Museums and art galleries
E. Schools and libraries
F. Economy
G. Government
II. History

Questions

Why is Paris called the *City of Light*?
Where in Paris is the Cathedral of Notre Dame?
What official heads the government of Paris?
What are the Left Bank and the Right Bank of Paris?
What did the ancient Romans call the Paris area?
When did Paris receive its present name?
What is Paris's highest hill? What is at its top?
What is the Eiffel Tower? Panthéon? Champs Élysées?
How did the Latin Quarter receive its name?
How was Paris saved from damage in World War II?

Paris, Pact of. See Kellogg-Briand Pact.

Paris, University of, is a government-supported university system in Paris and its suburbs. It consists of 13 units called the University of Paris I, II, III, and so on. The university is coeducational and has over 296,000 students, of whom about 51,000 are from other countries.

The university offers courses in economics, law, liberal arts, science, and many other fields. Each unit specializes in a particular group of subjects. For example, the University of Paris V concentrates on medicine and on pharmaceutical and biological sciences. Students attend lectures and participate in discussion groups.

The University of Paris, one of Europe's oldest universities, was organized during the 1100's. It became known as the Sorbonne, which was the name of its most famous college (see Sorbonne). In 1968, the government passed a law to reform higher education. As a result of this law, the university was reorganized in 1970 into the 13-unit system. P. A. McGinley

Parity, in physics, concerns the symmetry between an event and its reflection in a mirror. The idea of parity is a useful tool in quantum mechanics. Physicists say that *parity is conserved* when an event and its mirror image both satisfy identical laws of nature. In this case, an observer cannot tell the difference between the event and its reflection. The same laws apply to the event and its image, and give the observer no clue by which to identify one or the other. Parity is conserved in all ordinary mechanical and electrical systems.

Physicists once believed that the conservation of parity was a natural law that applied to all events. But in 1956, two Chinese-born physicists, Tsung Dao Lee and Chen Ning Yang, suggested a number of experiments which proved otherwise. The experiments showed that parity was not conserved in a type of nuclear event called a *weak interaction.* An example of such an event is the emission of an electron by a radioactive nucleus.

The first such experiment was performed at the United States National Bureau of Standards (now the National Institute of Standards and Technology) by C. S. Wu of Columbia University and E. Ambler, R. W. Hayward, D. D. Hoppes, and R. P. Hudson of the Bureau, who used atoms of the radioactive cobalt-60. The result of their experiment showed that parity conservation is not a universal law of nature. Chen Ning Yang

Parity, in economics, is equivalence in the values of currencies or in the prices of goods over time. In the United States, the word most commonly refers to agricultural policies aimed at providing farmers with fair prices for their products.

The Agricultural Adjustment Act of 1933 defined the first parity prices. The law calculated the prices at a level intended to give farmers the same purchasing power that they had during the years 1910 to 1914. The *base pe-*

riod of 1910 to 1914 was chosen because it represented a time when American farmers were prosperous. A scale called the *parity index* mathematically compared the prices of goods and services commonly bought by farm families to those same costs during the years 1910 to 1914. The prices farmers received for the goods they sold were compared in the same way to determine the index of prices received by farmers. Prices were said to be "at parity" when these two indexes were equal.

In 1948, the United States Congress created a new parity formula, designed to keep pace with market conditions, that is still used today. Under this formula, the parity price for a product is determined by multiplying the product's average price over the past 10 years by the current parity index. The resulting figure is divided by the index of prices received averaged over the past 10 years. The index of prices received and the parity index are still determined using the 1910 to 1914 base period.

The U.S. government has attempted to provide near-parity prices with such programs as government purchase of products, direct payments to farmers, and acreage allotments (see **Farm and farming** [Federal farm programs]). Some economists argue that increased farm productivity has changed price and cost relationships dramatically since the 1910 to 1914 base period. Thus, they say, parity prices are too high, and overproduction and surpluses have been frequent. Warren F. Lee

Park. Most parks are sections of land set aside for enjoyment by the public. Many parks are used for recreation and to allow visitors to relax in a natural environment. Some parks are used for cultural and educational events, sports, rallies, and festivals. Parks come in many sizes, from a tiny city park less than a block square to national parks containing vast areas of wilderness. Local, state or provincial, and national governments throughout the world administer park systems. Some parks are privately owned and administered but admit the public.



Cary Wolinsky, Stock, Boston

State, provincial, and national parks help preserve the unspoiled beauties of nature. In this picture, a park ranger teaches young campers about Devil's Lake State Park in Wisconsin.



Frank Wing, Stock, Boston

Urban parks contribute natural beauty, greenery, and open space to cities and towns. Queen Elizabeth Park, *above,* is an urban park in the center of Vancouver, British Columbia.

Other parks are not open to the public.

Kinds of parks. There are many kinds of parks. This article describes two main kinds: (1) urban parks and (2) state, provincial, and national parks. For information on theme or amusement parks, see **Amusement park.**

Urban parks provide greenery and open space that add variety to city and town landscapes. Such parks are generally administered by local government bodies. Many urban parks have picnic areas, and some have trails for biking, horseback riding, jogging, and walking. Some parks also have zoos and recreational facilities for basketball, tennis, and other sports. At many lakeside parks, visitors may swim, sail, or canoe. Some parks sponsor classes in such recreational activities as nature study and crafts.

In the United States and Canada, most urban areas have at least one large park and many small parks. Fairmount Park in Philadelphia is one of the largest city parks. It includes a zoo, a theater, an outdoor amphitheater, and six colonial mansions open to the public.

State, provincial, and national parks serve a number of purposes. For example, many national governments set aside land to preserve spectacular mountains or lakes, dense forests, or unusual wildlife. Some parks include geysers, glaciers, or interesting rock formations.

State, provincial, and national governments also preserve areas for their historic value or for recreational use. For example, some parks contain historic battlefields, buildings, or ruins. Many parks offer campgrounds, trails, or skiing areas. Lakes in some parks are used for swimming and other water sports.

The United States has about 5,000 state parks and 50 national parks. Canada has about 1,200 provincial parks and 35 national parks. Its national park system has more land than any other national park system in the world.

History. Historians credit the ancient Sumerians of Mesopotamia with creating the first parks during the

2300's B.C. Many early parks featured hunting areas or elaborate gardens. In general, such parks were developed by wealthy people for their own private use.

The first public parks probably appeared in Greece. By the late A.D. 1200's, small public parks had become common in many European cities. The first public park in colonial North America was established in 1634 in Boston and called Boston Common. The park is still a popular recreational site in downtown Boston. In 1858, work began on Central Park in New York City. Two landscape architects, Frederick Law Olmsted and Calvert Vaux, designed the park. Their attempt to create a rural atmosphere in the park influenced the design of many city parks in the United States.

In 1864, California established the first two state parks in the United States. In 1872, the U.S. Congress passed a bill to establish Yellowstone National Park, the world's first national park. Banff National Park, created in 1885 as Hot Springs Reservation, became the first national park in Canada. In 1916, the National Park Service was established to administer the national parks in the United States. In 1917, Illinois set up the first state agency for managing a state park system. Roger A. Lancaster

See also **National park; National Park System; Canada** (table: National park system); **Recreation; Olmsted, Frederick Law; Landscape architecture;** and the *Recreation* section of major city articles, such as **San Francisco** (Recreation).

Park, Mungo (1771-1806), was a Scottish explorer who led one of the first European expeditions to investigate the course of the Niger River in western Africa. He had an important role in the European exploration of Africa.

Park was born near Selkirk, Scotland. He became a surgeon, but also developed an interest in botany. This interest brought him to the attention of the African Association, a British organization formed to promote exploration of Africa. In 1795, the association sent Park to explore the Niger River. Park reached the Niger near present-day Ségou, Mali, in June 1796. He followed the river a short way and saw that it flowed eastward, not westward as Europeans had thought.

In 1805, Park led a British government expedition to trace the course of the Niger River. Early in 1806, he sailed downstream to the Bussa rapids, now part of Kainji Lake in Nigeria. He drowned there while trying to escape an attack by Africans. Robert I. Rotberg

Park, National. See National park.

Park Chung Hee (1917-1979) served as president of South Korea from 1963 to 1979. He had taken power as head of the nation in 1961 after leading a military revolt against the civilian government. In 1979, Park was assassinated by the head of the country's Central Intelligence Agency.

Park, a controversial leader, helped establish many new industries in South Korea, and the country's economy grew rapidly under his rule. On the other hand, Park's government greatly restricted individual rights. For example, the government made it illegal to criticize the president or the constitution, which gave the president almost unlimited power. Park had many people imprisoned for criticizing his policies. He said harsh rule was needed to guard against attack by North Korea.

Park was born in Sonsan-gun, a county in North Kyongsang Province. In the early 1940's, he attended military academies and served in the Japanese Army. He entered the Korean Military Academy in 1945. Park became a Korean Army captain in 1946 and a general in 1953. After leading the 1961 military revolt, he headed a military government for two years. In 1963, Park resigned from the army and was elected president by the voters to head a new civilian government. He was reelected by the voters in 1967 and 1971. In 1972 and 1978, Park was reelected by an electoral college made up of persons loyal to him. Chong-Sik Lee

See also **Korea** (South Korea under Park).

Parker, Alton Brooks (1852-1926), an American judge and politician, won the Democratic Party nomination for United States President in 1904. He opposed President Theodore Roosevelt, who was running for reelection. The party leaders hoped that Parker, a highly respected conservative, would win the votes of many who were opposed to Roosevelt's progressivism. But Roosevelt's great popularity decisively defeated Parker.

Parker was born in Cortland, New York, and graduated from Albany Law School. He served on several lower state courts in New York. In 1897, he became chief justice of the New York Court of Appeals, the state's highest judicial office. Robert W. Cherny

Parker, Charlie (1920-1955), an alto saxophonist and composer, ranks among the most influential musicians in jazz history. Parker and trumpeter Dizzy Gillespie were responsible for the rise of *bebop,* a complex rhythmic, melodic, and harmonic form of jazz that developed in the 1940's. His many recordings illustrate his amazing technique and the richness of his musical ideas. Several of his compositions, including "Ornithology" and "Confirmation," became jazz standards.

Charles Christopher Parker, Jr., was born in Kansas City, Kansas. He was nicknamed "Bird" or "Yardbird." Parker worked in the bands of Jay McShann, Earl Hines, and Billy Eckstine before forming his own combos in the 1940's. The period from 1944 through 1953 contains the works of his mature style. Parker's improvisations brought new life to a limited number of works that included 12-bar blues, popular songs, a few jazz standards, and compositions based on the harmonies of popular songs. From his youth, Parker was addicted to heroin. His addiction led to many physical and emotional ills during his last years.

Many musicians have learned their craft by imitating Parker's music. A number of the musicians he worked with also influenced the development of jazz. These people include Gillespie, Thelonious Monk, Miles Davis, and Max Roach. Frank Tirro

See also **Jazz** (Bebop; picture).

Parker, Dorothy (1893-1967), was an American poet and short-story writer. She also won fame for her witty conversation and literary criticism.

Most of Parker's verse and stories express a humorous but cynical disappointment with life. She often wrote in a biting, ironic style about the loss of love and idealism. Her precise use of language gives her writing a crisp, conversational tone. One of her most quoted poems, "News Item" (1926), observes that "Men seldom make passes/At girls who wear glasses." Parker's poetry was published in *Enough Rope* (1926), *Sunset Gun* (1928), and *Death and Taxes* (1931). In her short stories, Parker examined the hypocrisy of modern society while show-

ing compassion for its victims. *Here Lies* (1939), a collection of these stories, includes such works as "Mr. Durant" (1924) and "Big Blonde" (1929).

Parker began her literary career in 1916 as a writer for a women's magazine. In 1925, she became one of *The New Yorker* magazine's first regular contributors. She wrote for its book review column for several years. Parker's book reviews were published in *Constant Reader* (1970), a book named for the title of the column.

During the 1920's, Parker belonged to the Algonquin Round Table, a group of famous writers who met regularly at the Algonquin Hotel in New York City. She became known for her quick-witted quips.

Dorothy Rothschild Parker was born in West End (now part of Long Branch), New Jersey, and spent most of her life in New York City. She wrote under her married name, though she divorced Edwin Pond Parker in 1928. Marcus Klein

Parker, Ely Samuel (1828-1895), was the first Indian to serve as United States Commissioner of Indian Affairs. President Ulysses S. Grant appointed Parker, a Seneca Iroquois Indian, in 1869.

Fighting between the Indians and the whites decreased during Parker's term as commissioner, largely because the Indians trusted him. Parker made many enemies among white politicians because he defended Indian rights. His enemies accused him of bribery and fraud. An investigation proved Parker's innocence, but he resigned as commissioner in 1871.

Parker was born in Pembroke, New York, near Batavia. His Indian name was *Do-ne-ho-ga-wa,* which means *Keeper of the Western Door of the Long House of the Iroquois.* His father was a Seneca Iroquois chief, and his mother's ancestors included an Iroquois prophet.

As a young man, Parker studied law. But few Indians of the 1800's were considered citizens, and so New York would not permit him to practice law. He then attended Rensselaer Polytechnic Institute and became a civil engineer. During the American Civil War (1861-1865), he served as General Grant's military secretary. Parker wrote out the terms of the final Confederate surrender, as set forth by Grant. Parker became a brigadier general in 1867. He resigned from the Army when he became Commissioner of Indian Affairs. Beatrice Medicine

Parker, Francis Wayland (1837-1902), an American educator, exerted great influence on modern educational practice. He urged that classrooms be informal and free from old-time strict discipline, and that the child be made the center of the educational process. Parker also developed strong programs of science and geography in the elementary schools. In 1883, he became head of the Cook County (Chicago) Normal School and began teaching his methods to teachers. In 1899, he founded the Chicago Institute. When this school became the University of Chicago's department of education, Parker became the director of the department.

Parker was born in Bedford Township, New Hampshire. He taught in New Hampshire and Illinois. In 1872, he went to Germany to study education. Glenn Smith

Parker, Quanah. See Quanah.

Parker, Robert B. (1932-), an American author of detective stories, created the private investigator known only as Spenser. Parker introduced Spenser in the novel *The Godwulf Manuscript* (1974).

Spenser is a tough, wisecracking investigator based in Boston. He works on many of his cases with his friend Hawk. Continuing themes in the series include Spenser's love of cooking; his romance with psychologist Susan Silverman; and his concern with the problems of women and adolescents. These themes set Spenser apart from earlier hard-boiled detectives and influenced many other authors of detective fiction.

Parker has also written detective novels about Jessie Stone, a small-town New England police chief. The series began with *Night Passage* (1997)." Parker's novels have been praised for their excellent dialogue. He was influenced by American author Raymond Chandler, creator of the private investigator Philip Marlowe. Parker completed *Poodle Springs* (1989), a Marlowe novel Chandler had left unfinished at his death. Parker also wrote *Perchance to Dream* (1991), a sequel to Chandler's *The Big Sleep* (1939). Robert Brown Parker was born in Springfield, Massachusetts. Jon L. Breen

Parker, Theodore (1810-1860), was an American Unitarian clergyman and social reformer. He belonged to a philosophical movement called *transcendentalism* (see **Transcendentalism**). Parker was born in Lexington, Massachusetts. From 1837 to 1846, he was pastor of a Unitarian church in West Roxbury, Massachusetts, near Boston. During this period, he caused great controversy by insisting that Christians reject the Bible and religious doctrines and rituals. Parker urged Christians to worship God directly. Unlike the transcendentalist leader Ralph Waldo Emerson, however, Parker did not totally oppose organized religion. In 1841, he stated his views on religion in a sermon called "Discourse on the Transient and Permanent in Christianity." During the 1850's, Parker became one of the leading abolitionists. John Clendenning

Parkinson disease is a disorder that gradually destroys cells in certain regions of the brain involved in moving the body. Symptoms include trembling hands, rigid muscles, slow movement, and problems with balance. The disease is named for English physician James Parkinson, who first described the condition in his 1817 work *An Essay on the Shaking Palsy.*

Symptoms of Parkinson disease occur because the condition gradually kills nerve cells that release *dopamine.* Dopamine is a *neurotransmitter,* a chemical that carries messages from one nerve cell to another. Loss of dopamine disrupts communication pathways among nerves that help control movement.

As more cells die, patients have increasing difficulty controlling certain movements. A person with Parkinson disease often walks with a shuffle and finds it hard to write clearly or button clothes. Face muscles may grow rigid, causing a "masklike" expression. Patients may have trouble beginning such movements as rising from a chair. The disease may have psychological effects, including depression and *dementia* (decreased mental ability). The condition may cause serious disability.

Causes. Doctors do not know what causes the most common form of Parkinson disease, which occurs chiefly in people 50 to 70 years old. Some rare forms of the disease that tend to strike people less than 50 years old are caused by defects in *genes* (chemical units of heredity). But research suggests that most cases are not caused by genetic abnormalities.

Parkinson disease due to unknown causes is the most

common form of a group of disorders with similar symptoms called *Parkinsonism.* Other causes of Parkinsonism include certain drugs and exposure to toxic quantities of carbon monoxide.

Treatment with drugs. One of most effective approaches to treatment aims to replace the brain's lost dopamine. Dopamine itself cannot be given as a drug, because it does not cross from the bloodstream into the brain. But a drug called *levodopa* or *L-dopa* does enter the brain, where surviving nerve cells transform it into dopamine. For many patients, L-dopa at first brings dramatic improvement in symptoms. But as the disease progresses, L-dopa becomes less effective in most patients. Many patients also develop troubling side effects, including abnormal movement, sudden changes in muscle control, sleeplessness, vivid nightmares, hallucinations, and confusion. See **Dopamine.**

Drugs called *dopamine receptor agonists* behave somewhat like dopamine in the brain. Dopamine receptor agonists include *pergolide, bromocriptine, pramipexole,* and *ropinirole.* Many patients take these drugs in combination with L-dopa.

Drugs called *anticholinergics* also help control some symptoms, particularly trembling. Still other drugs increase the amount of dopamine available by inhibiting the action of substances that break down L-dopa. Two of these drugs are *tolcapone* and *entacapone.*

Another drug that relieves symptoms, called *selegiline,* has raised interest as a possible means to prevent some of the nerve damage that occurs in Parkinson disease. But studies have failed to produce strong evidence that selegiline slows progression of the disease.

Other treatments. In some cases, doctors may use surgery to destroy particular areas of the brain that produce symptoms of Parkinson disease. Two of these surgical procedures are called *thalamotomy* and *pallidotomy.* Another approach involves implanting a device called a *deep brain stimulation system* that delivers electrical pulses to certain areas of the brain. Researchers continue to explore the possibility of replacing Parkinson patients' lost dopamine-producing cells with transplanted cells from other sources. William J. Weiner

Parkinson's law is a humorous criticism of the administration of business or government. This "law" is based on the idea that "work expands so as to fill the time available for its completion." The law states that the number of administrators increases, whether or not their official responsibilities increase. Such growth supposedly occurs because these officials create assistants. These assistants, in turn, create new work.

C. Northcote Parkinson, a British historian, developed the law in 1957 in his book *Parkinson's Law and Other Studies in Administration.* He applied his law to government administration. But today, people use it to explain almost any situation in which the staff increases faster than the work to be done.

Parkinson supported his law with statistics. For example, he found that the number of administrative officials in the British navy rose 78 percent from 1914 to 1928. But in that period, the United Kingdom reduced its fleet about 68 percent. Critically reviewed by Robert T. Golembiewski

Parkman, Francis (1823-1893), one of America's greatest historians, wrote vivid accounts of the role of the Indians in North American history. He made a famous journey on the Oregon Trail in 1846 and lived with the Indians for months to gather material for a book. Published in 1849 as *The California and Oregon Trail,* it later became famous as *The Oregon Trail.* Parkman also made a thorough study that included five trips to Europe for material before he published *History of the Conspiracy of Pontiac* (1851).

He also wrote *France and England in the New World,* a seven-volume series. These books described the history of the struggle between France and Britain for control of North America, and the part the Indians played in it. The series included *Pioneers of France in the New World* (1865), *The Jesuits in North America* (1867), *The Discovery of the Great West* (1869), and *Montcalm and Wolfe* (1884). Parkman's books did not include the economic elements of history now considered important, but they were so realistically written that they still may be read with great pleasure.

Parkman's health had been damaged by the hardships of his trip on the Oregon Trail. He lost much of his sight, but continued his work with the help of a reader. Parkman studied horticulture as a hobby and was so successful that he became a professor of horticulture at Harvard University in 1871.

Parkman was born in Boston. He graduated from Harvard University and later studied law there. He was elected to the Hall of Fame for Great Americans in 1915.

Robert C. Sims

Parks, Rosa Louise (1913-), an African American civil rights activist, is best known for her role in a 1955 boycott of the Montgomery, Ala., bus system. Parks triggered the boycott when she refused to give up her seat to a white passenger on a bus. Her action helped bring about the civil rights movement in the United States.

Parks was arrested for violating a city law requiring that whites and blacks sit in separate rows on buses. She refused to give up her seat in the middle of the bus when a white man wished to sit in her row. The front rows were for whites only. The law required blacks to leave their seats in the next rows when all seats in the front rows were taken and other whites still wanted seats.

Even before Parks's arrest, Montgomery's black leaders had been discussing a protest against racial segregation on the city's buses. Parks allowed the leaders to use her arrest to spark a boycott of the bus system. The leaders formed an organization to run the boycott. Martin Luther King, Jr.—then a Baptist minister in Montgomery—was chosen as president.

For 382 days, from Dec. 5, 1955, to Dec. 20, 1956, thousands of blacks refused to ride Montgomery's buses. Their boycott ended when the U.S. Supreme Court declared segregated seating on the city's buses unconstitutional. The boycott's success encouraged other mass protests demanding civil rights for blacks.


Edwin H. Remsberg, Gamma Liaison
Rosa Louise Parks

Parks was born in Tuskegee, Ala. She attended Ala-

bama State Teachers College. She held a variety of jobs and, in 1943, became one of the first women to join the Montgomery Chapter of the National Association for the Advancement of Colored People (NAACP). She served as the organization's secretary from 1943 to 1956.

Parks lost her job as a seamstress as a result of the Montgomery boycott. She moved to Detroit in 1957. From 1967 to 1988, she worked on the Detroit staff of John Conyers, Jr., a Democratic member of the U.S. House of Representatives. In 1979, she won the Spingarn Medal for her work in civil rights. She wrote an autobiography, *Rosa Parks: My Story* (1992). In 1999, she was awarded a Congressional Gold Medal.

David J. Garrow

Parliament is the national lawmaking body of the United Kingdom, Canada, Australia, Japan, and other democratic countries. Some parliaments are made up entirely of elected representatives. Others have both elected and appointed or hereditary members.

A parliamentary government differs from the system of government in the United States, where the president and vice president are elected separately from Congress. In a parliamentary government, the top officials are known as *ministers* (heads of government departments). The ministers make up an executive body that is called the Cabinet. They are also members of parliament, and so they carry out legislative functions as well. The top officials are elected by the voters of the district that they represent, rather than by the entire nation. However, the Cabinet functions under the control of the parliament as a whole. The Cabinet remains in power only as long as it has the support of a majority of the members in parliament.

In most countries with parliamentary government, the chief executive is called the *prime minister.* The prime minister is the leader of the largest party in parliament or of a *coalition.* A coalition is a temporary joining of parties that together have a majority of seats. The prime minister is formally appointed by the official head of state. The official head of state may be the king or queen of a monarchy or the president of a republic. In most parliamentary governments, the prime minister chooses members of his or her own political party to become ministers. The most important ministers belong to the Cabinet. Parliamentary government is also called *Cabinet Government,* because control rests with the Cabinet.

Members of parliament are elected to a maximum term of office. At the end of the term, an election must be held. But a general election may occur at any time short of a full term. For example, the Cabinet may resign and a new election be held if parliament defeats a program the prime minister considers essential. An election also must occur if parliament votes "no confidence" in the Cabinet.

The British Parliament

Unlike the Congress of the United States, the British Parliament does not obtain its authority from a written constitution. Instead, Parliament's power developed gradually over many centuries and is based on tradition and custom as well as written law.

Parliament consists of the *monarch* (king or queen); the House of Commons, which is often called simply the *Commons;* and the House of Lords, which is often called the *Lords.* But in daily conversation, the term *Parliament* means just the Commons and the Lords. The power of the Commons greatly exceeds that of the monarch or of the Lords. Although the monarch officially has the power to reject legislation passed by Parliament, no British ruler has done so since the early 1700's.

The House of Commons is the real governing body of the United Kingdom, though it is called the *lower house* of Parliament. The term *lower house* refers to the branch of a lawmaking body considered closer to the people. The House of Commons, like nearly all other lower houses, consists of representatives who are elected by popular vote.

The House of Lords may delay, but not defeat, legislation passed by the Commons. Money bills passed by the Commons become law within one month, even without approval of the Lords. Nonmoney bills passed by the Commons in two consecutive sessions automatically become law a year after the second passage.

The House of Commons has 659 members—529 from England, 40 from Wales, 72 from Scotland, and 18 from Northern Ireland. The prime minister and most Cabinet

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Commons Chamber is the room where the House of Commons meets. It was rebuilt after a German air raid destroyed it in 1941, during World War II. It reopened in 1950. The Government members sit at the left, and the Opposition members at the right.

ministers are members of the Commons. Each member represents a voting district called a *constituency.* Members are not required to live in the constituency they represent. Clergy of the Church of England, the Church of Scotland, the Church of Ireland, and the Roman Catholic Church cannot be elected to the Commons. Members of the House of Lords and certain government officials also are ineligible. Members of the House of Commons receive an annual salary. They also get travel and administrative expenses.

How members are elected. Members of the Commons are chosen in a *general election,* in which all voters may take part. If a member dies or resigns, the constituency chooses a new representative in a *by-election.*

Members of the House of Commons are elected to a maximum term of five years, after which Parliament must be dissolved and another election held. But an election may be called at any time, and most Parliaments *sit* (are in session) for less than five years. The prime minister may call for a new election if Parliament refuses to support the Cabinet's policies. The prime minister also may call for a vote if he or she believes the country's political climate favors another victory by his or her party.

How the House of Commons works. The House of Commons sits for about 160 days annually from November to October. Most sessions last from midafternoon to evening, though some continue through the night.

The Commons meets in a long room with rows of benches running along two sides. The Speaker of the House of Commons sits at one end of the chamber. The Speaker presides over the sessions, grants members the right to speak, and keeps order during debates. Members of the prime minister's party, representing the *Government,* sit on the benches to the Speaker's right. Members of other political parties supporting the Government also sit on that side of the room. Members of the second largest party, called the *Opposition,* and their supporters sit to the left of the Speaker. The leaders of the Government and the Opposition are known as the *front bench* because they sit on the benches nearest the center of the chamber. Other members sit behind them and are known as the *back bench.*

The Government and the Opposition debate most proposed legislation. Other discussion between the two sides takes place at the question periods at the opening of the order of business. Members of the Opposition question the prime minister and other members of the Government about their policies.

The House of Lords is called the *upper house* of Parliament, though it has less power than the House of Commons. The term *upper house* refers to the branch of a lawmaking body that is less subject to control by the voters. This house, for example, is not an elected assembly. Most of its members are honorary appointees.

The main function of the House of Lords is to review legislation passed by the House of Commons. Although the Lords can amend bills, it rarely changes their basic principles. The Lords also serves as the United Kingdom's highest court of appeals.

The House of Lords has about 700 members, including 92 *hereditary peers and peeresses,* about 600 *life peers and peeresses,* and 26 *lords spiritual.* Hereditary peers and peeresses are members of the nobility who have inherited their titles. In 1999, reforms went into effect that limited the number of hereditary peers or peeresses in the House of Lords. Life peers and peeresses are appointed to the Lords to honor their achievements in business, civil service, or other fields. They have the title of baron or baroness. The life peers and peeresses include about 30 *law lords,* also called *lords of appeals,* who are chosen from among the United Kingdom's highest-ranking judges. They form the final court of appeal for civil cases throughout the country and for criminal cases in England, Wales, and Northern Ireland. Lords spiritual are senior members of the Church of England. Life peers, law lords, and lords spiritual are appointed to their seats for life. Their children do not inherit their titles.

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The Lords Chamber, where the House of Lords meets, was first occupied in 1847. The cushioned benches on the left form the main seating area for Government members, and the benches across the aisle are for the Opposition members.

Members of the House of Lords are not paid a salary. However, they do receive travel expenses.

The Houses of Parliament. Parliament has met on the same site in London since 1547. For nearly 300 years, it met in St. Stephen's Chapel in the Palace of Westminster. A fire destroyed that building in 1834. The present Houses of Parliament were completed in 1860. Like the old building, they are known officially as the Palace of Westminster. In 1941, during World War II, a German bomb demolished the meeting chamber of the House of Commons. The present chamber was finished in 1950.

History. The British Parliament developed from a council of nobles and high-ranking clergy that advised the early kings of England. After the Norman Conquest in 1066, this informal advisory group became a formal assembly called the Great Council. It met three times yearly to help the king decide matters of government policy and to make laws.

During the early 1200's, King John began to call knights elected from the *shires* (counties) to some meetings of the Great Council. He summoned the knights to obtain their approval of taxes he had levied, because tax collection would be difficult without their cooperation. In the mid-1200's, the English statesman Simon de Montfort enlarged the council, by then called Parliament, to include elected representatives from towns, shires, and boroughs. The meeting King Edward I called in 1295 became known as the *Model Parliament,* because it resembled later Parliaments.

By the mid-1300's, the elected representatives began to meet separately from the nobles and bishops, and Parliament was divided into two houses. By the late 1300's, the Commons obtained the right to consider tax legislation before it was discussed by the Lords. But the Commons had no power to initiate legislation. It could only ask the monarch to grant requests. By the early 1400's, the Commons gained the right to introduce bills.

Parliament gains strength. As its role in government increased, Parliament demanded greater power. During the 1620's, the struggle between Parliament and the king became bitter. In 1628, Parliament forced King Charles I to sign the Petition of Right, a document that limited royal power. However, Charles refused to obey the agreement. He did not allow Parliament to meet from 1629 until 1640, when he was forced to call a meeting to obtain funds. But Parliament refused to provide any money unless Charles obeyed the Petition of Right. He refused, and civil war broke out. In 1649, Parliament ordered Charles beheaded. The legislature, led by the Puritan general Oliver Cromwell, declared England a republic and ruled until 1653. Because the same Parliament had remained in session since 1640, it became known as the *Long Parliament.* Cromwell then ruled as a dictator until his death in 1658. In 1660, a new Parliament restored the monarchy.

The Bill of Rights of 1689 gave Parliament the right to meet frequently and have freedom of speech during debates. It also confirmed the right of the Commons to control financial legislation. By the early 1700's, Parliament had gained almost total control over the monarchy. In 1707, the Act of Union joined England, Scotland, and Wales together to form the Kingdom of Great Britain. The act established a single national parliament.

During the 1800's, the membership of Parliament changed dramatically. In the early 1800's, nobles and other wealthy landowners controlled most of the members of Parliament, including the House of Commons. Some districts with almost no voters had representation, while districts with large populations had none. Few citizens had the right to vote. In 1832, Parliament passed a reform act that distributed seats on the basis of population. The act also reduced the property requirements for voting to give most middle-class men, but no women, the right to vote. The Reform Acts of 1867 and 1884 extended the vote to nearly all adult males. In 1928, women received full voting rights.

The decline of the House of Lords. During the 1800's, the two houses of Parliament remained nearly equal in power. Although the Commons had control over money bills, the Lords had the power to veto legislation. In 1909, the Lords rejected a budget approved by the Commons. A struggle broke out between the two houses of Parliament, which resulted in the Parliamentary Act of 1911. Under this act, the House of Lords lost its veto power. The Lords was permitted to delay money bills for only one month and nonmoney bills for two years. The Parliamentary Act of 1949 reduced to one year the length of time that the Lords could postpone nonmoney bills. In 1999, legislation abolished the right of hereditary peers to inherit a seat in the Lords along with their title. Ninety-two hereditary peers, most of whom were elected by other hereditary peers or by the full House of Lords, were to continue to serve in the Lords until further reform of the house was completed.

Parliaments in other countries

The parliaments of Canada, Australia, and New Zealand greatly resemble the British Parliament. The Canadian Parliament has two houses—the Senate and the House of Commons. Senators are appointed and have less power than do the elected members of the House of Commons. The Parliament of Australia, called the Federal Parliament, is made up of the Senate and the House of Representatives. Members of both houses are elected. Most bills are introduced in the House of Representatives, which has more power than the Senate does. The New Zealand Parliament consists of one house, the House of Representatives, whose members are elected. India, South Africa, and many other former British colonies also have parliaments.

The parliament of Germany consists of the Bundestag, an elected assembly, and the Bundesrat, whose members are appointed. Japan's parliament, which is called the Diet, has two elected houses. The Althing of Iceland, the world's oldest parliament, has existed since A.D. 930.

Robert E. Dowse

Related articles. See the *Government* section of the articles on countries mentioned in this article. See also:

Cabinet
Government
Gunpowder Plot
House of Commons
House of Lords
Inter-Parliamentary Union
Long Parliament
Ministry
Model Parliament
Montfort, Simon de
Petition of Right
Prime minister
Rump Parliament

Additional resources

Canadian Parliamentary Guide. Gale Research, published annually.

Silk, Paul, and Walters, R. H. *How Parliament Works.* 4th ed. Longman Pub. Group, 1998.

Parliamentary procedure is a way to conduct a meeting in an orderly manner. Parliamentary procedure, also known as *rules of order,* helps the presiding officer keep order during a meeting as well as guide participants in transacting business. The procedure is called *parliamentary* because it comes from the rules and customs of the British Parliament. By the end of the 1600's, the broad principles had become well established. As actual procedures developed, they became the basis for deciding later questions of parliamentary law. In 1876, Major Henry M. Robert, a United States Army Engineer, wrote what became the most popular book on parliamentary procedure, *Robert's Rules of Order.*

Any group that conducts its meetings according to parliamentary rules will encounter questions about the proper procedure to be used. To answer such questions, the group should consult *Robert's Rules of Order* or another standard authority on parliamentary procedure. All such authorities tend to follow the same general principles, but they may differ on specific points. Thus, an organization should adopt a single authority for consistency.

Any system of parliamentary procedure should be both democratic and efficient. To ensure democracy, the rights of the minority must be protected and all members of the group must be able to discuss a matter before the majority disposes of that matter. To be efficient, the procedure must assist the group with a minimum of confusion and delay. It must also ensure that all members are aware of the substance and implications of each matter considered.

Forming an organization

A group that wishes to form an organization first calls a meeting of those who may be interested. At this meeting, a temporary organization is established. The group selects an acting presiding officer and an acting secretary, who begins keeping a record of the business transacted. The members then elect a temporary presiding officer and a temporary secretary, who serve until the organization is established permanently and permanent officers are elected.

Bylaws. Before a group officially becomes a permanent organization, it must prepare a set of *bylaws.* The bylaws can be prepared by a committee elected by the organization or appointed by the temporary presiding officer. The bylaws may be adopted as suggested by the committee, or they may be changed through the process of discussion and voting.

The bylaws should define the characteristics of the organization and describe how the organization will operate. They should also include any rules that the organization considers sufficiently important to require prior notice and a large majority for changing. These rules cannot be suspended except as provided for in the bylaws.

Adoption of the first set of bylaws requires a majority vote by the members of the organization. Upon adoption, the bylaws immediately go into effect. As soon as possible, all members should be provided with a copy, as well as copies of other pertinent documents.

Officers. The essential officers for any organized group are a president and a secretary. If the members pay dues or raise money for the organization in any way, a treasurer is also necessary. Some groups have an officer who serves as both secretary and treasurer.

The president (1) presides over all meetings, (2) supervises the work of other officers and committees, (3) represents the organization, and (4) appoints committees if the bylaws grant the officer this power.

The secretary (1) notifies members of scheduled meetings, (2) keeps and reads the minutes, and (3) handles correspondence.

The treasurer (1) handles all the organization's finances, (2) keeps a record of income and expenses, and (3) helps prepare the annual budget.

Other officers. Many organizations, especially if they are large or carry on extensive activities, have additional officers. These usually include a *vice president,* who aids the president and takes the president's place when that officer is unable to perform the duties of the position. An organization may divide the secretary's job between a *recording secretary,* who keeps the minutes and other records, and a *corresponding secretary,* who handles all letter-writing. Some clubs elect a *historian,* who keeps a permanent record of activities and members, and a *sergeant at arms,* who maintains order during meetings. A club might also have a *parliamentarian.* The parliamentarian advises the president on matters of procedure.

Electing officers. Most organizations elect officers once a year. There are two methods of nominating officers. Under the first method, the group chooses a nominating committee to propose one or more candidates for each office. After the committee makes its nominations, other candidates may be nominated *from the floor* (by the members attending the meeting). Under the second method, the presiding officer declares that "nominations are in order." He or she then accepts nominations from the floor for each office.

A vote for officers, like votes on other business matters, may be held (1) by a show of hands or (2) by secret ballot. There are fewer risks of embarrassing any of the candidates when the members vote by secret ballot. In addition, the candidates do not have to leave the room during the voting. If only two candidates are nominated for an office, one must receive a majority of the votes to win. Usually, if three or more are nominated, the one who receives a *plurality* (the most votes) wins. But the bylaws may require that a candidate must receive a majority vote to be elected. In such cases, the winner would be chosen in a run-off election between the two candidates with the most votes.

Committees handle many duties that a group's officers do not or cannot perform. They also do jobs that cannot be done by the entire membership at regular meetings. Most organizations have two types of committees: (1) standing committees and (2) special committees.

Standing committees deal with regular and continuing matters, such as membership and finance. These committees are usually selected after each annual election, and they *stand* (remain active) through the year.

Special committees may be selected at any time to deal with specific matters. This committee might be appointed to plan a social event, to revise the group's bylaws, or to nominate new officers. The special committee ceases to exist after it completes its assigned task.

Bylaws usually state whether standing committees shall be appointed or elected. If they are to be appointed, the president names the members of each committee. The president usually creates special committees and appoints their members. Organization members can also create special committees by voting to do so. Each committee should have an odd number of members, in order to avoid tie votes on committee decisions. The president may select one of the committee members to be chairperson, or the committee may elect its own chairperson. He or she participates in the discussion and voting. Committees do not have to follow the rules of parliamentary procedure. Thus, their meetings are usually informal discussions.

Holding meetings

A meeting officially begins when a *quorum* is present and the presiding officer calls the group to order. A quorum is the minimum number of members who must be present in order for the organization to transact business. In most organizations, a majority of the membership must be present in order to have a quorum. But a group's bylaws can name any part of the total membership as a quorum.

Order of business. If the organization's bylaws do not prescribe an order of business, there is a series of steps that are commonly accepted: (1) call to order at the appointed meeting time with a quorum present; (2) read, correct, and approve the minutes of the previous meeting; (3) hear reports of officers; (4) hear reports of boards; (5) hear reports of standing committees; (6) hear reports of special committees; (7) consider unfinished business; (8) consider new business; (9) hear announcements and requests that require no formal action; and (10) adjourn.

Minutes. The secretary's minutes should be an accurate record of all the organization's actions. At the start of each meeting, the secretary reads the minutes of the previous meeting so the members can recall the actions taken. The minutes do not summarize the discussions that take place during the meeting. They simply state the actions proposed, and what the organization decided to do about each one.

In most organizations, the secretary records the minutes in a book. Each set of minutes begins with the date and place of the meeting, the time the meeting began, and the name of the presiding officer. Some groups call the roll at the beginning of each meeting, and include a list of the members present in the minutes.

After the secretary has read the minutes, the president asks whether any member wants to make any corrections or additions. If so, the group must vote on each correction or addition. The president then asks for approval of the minutes. In some organizations, a member must propose that the group approve the minutes. But the simplest way is for the president to state that if there are no objections, the minutes will be considered approved. The secretary notes the approval and the date at the end of the minutes.

Motions. A *motion* is a brief, precise statement of a proposed action. A member can make a motion only when that member has been recognized by the presiding officer and *has the floor*—that is, has been given permission to speak. Some motions require a second before they can be discussed by the group. The act of seconding does not commit that member to supporting the motion. It signifies that member's interest in having the motion considered. After a motion has been made and seconded, the presiding officer restates the motion for the benefit of the rest of the members. In the case of a complicated motion, the secretary may be asked to read the motion from the minutes. The members then debate the motion. Perhaps the members want to *amend* (change) the motion in some way. If so, they must propose and *pass* (approve) a new motion amending the original motion. They must then debate the original motion as amended.

Debate on a motion usually continues until each member who wants to speak has done so. But the members can end the debate at any time by passing a motion to have the group vote immediately. To do so, a member would *move the previous question.* The members can also pass a motion to set a time limit on the debate. In legislative bodies, this rule of parliamentary procedure is known as *cloture.* See **Cloture**.

Each motion must be resolved of in some way before the group can take up another item of business. If the members want to postpone action on a motion, they may vote to "table the motion." The presiding officer or the group may dispose of a motion temporarily by referring it to a committee. The committee investigates the matter and presents a report at a later meeting. The group then decides what action it wants to take on the motion. Eventually, all motions must be either approved

Terms used in parliamentary procedure

Adjourn means to end a meeting.
Agenda is a list of items to be considered at a meeting.
Appeal is a request for a majority vote to overrule a decision of the presiding officer.
Chairman pro tempore is the temporary chairman.
Decorum in debate, *duh KOH ruhm,* refers to the observance of normal rules of courtesy and proper procedure while discussing motions.
Dilatory motion, *DIL uh TOH ree,* is a meaningless motion. The presiding officer must rule it out of order.
Division is a count of votes by a show of hands.
Gavel is a small wooden hammer. The presiding officer of an organization uses it to call meetings to order and to quiet disorder during the meeting.
Order of business is the series of steps covered in a meeting, from the call to order through adjournment.
Pending question is the motion under consideration.
Plurality is the largest number of votes received by any candidate in an election involving three or more candidates.
Point of order is an objection raised by a member because of improper procedure or annoying remarks. It must be ruled upon immediately by the presiding officer.
Question of privilege is a request that is made by a member who asks the presiding officer to deal with an emergency, disorder in the assembly, or other matters of general or personal welfare.
Ratify refers to a motion to approve an action already taken, such as a ruling by the presiding officer.
Recess is a temporary interruption of a meeting.
Unanimous consent refers to a request by the presiding officer on matters where differences of opinion are not expected. If there is an objection, a vote must be taken.

or disapproved by a majority of the membership.

Voting on motions takes place when there are no more requests to speak on a motion, or after debate has ended. First, the presiding officer restates the motion or has the secretary read it. Then the presiding officer calls for a *voice vote.* All in favor of the motion say "aye," then all those opposed say "nay." If the presiding officer cannot tell which side has the majority, he or she can ask supporters or opponents of a motion to stand or to hold up a hand.

The bylaws may require a *roll-call vote* on certain types of motions. A *secret ballot* is usually taken when electing officers and as required by the bylaws. A *majority vote* is more than half of the legal votes cast unless otherwise defined in the bylaws.

The presiding officer has the right to vote on all issues but usually only votes when that vote would change the result of the vote by the members. The presiding official may vote to break a tie vote. If the nay votes total one less than the aye votes, the presiding officer may cast a nay vote in order to create a tie vote and thus defeat the motion.

Parliamentary procedure does not have to be complicated and mysterious. As long as the presiding officer conducts meetings fairly and judiciously, and members learn the basic principles and procedures of parliamentary procedure, business can be transacted democratically and efficiently. Ned A. Shearer

Parma, *PAHR muh* (pop. 170,520), is a city in northern Italy. It lies about 75 miles (121 kilometers) southeast of Milan. For the location of Parma, see **Italy** (political map). Parma dates from the period of the Roman Republic (509 B.C. to 27 B.C.). It has many art treasures. Its cathedral dates from the 1000's. The building is an example of Lombard-Romanesque architecture. Its dome has a fresco, *Assumption of the Virgin,* by the artist Correggio (see **Correggio**). The University of Parma was founded in 1502. The area around Parma is famous for Parmesan cheese. Anthony James Joes

Parmenides, *pahr MEHN ih deez* (515?-450? B.C.), was the most important of the early Greek philosophers who lived before Socrates. Parmenides expressed his philosophy in a poem, *On Nature.* The complete poem has not survived, but large parts have been preserved.

Unlike previous Greek philosophers, Parmenides did not explain the origin of the world in terms of material substances, such as air or water. Instead, he deduced the nature of reality from logical arguments. Parmenides first argued that *what is not* is a notion that cannot properly be thought of or spoken of. Then he argued that if we eliminate *what is not* from our description of reality, *what is* turns out to be far different from what our senses tell us. Instead of a world made up of many changing things, *what is* is just one thing—unchanging, perfect, and without beginning or end. Parmenides was born in Elea, a Greek colony in Italy. Carl A. Huffman

See also **Pre-Socratic philosophy**.

Parnassus, *pahr NAS uhs,* is a mountain in Phocis in Greece. Its twin peaks rise to more than 8,000 feet (2,400 meters). In ancient times, Parnassus was considered one of the most sacred Greek mountains. It was described as a favorite place of the gods Apollo, Pan, and Dionysus and the goddesses called the Muses. The famous oracle of Delphi was located on its lower slope. Nearby was the Castalian spring. It was supposed to inspire those who drank from it to write poetry. Justin M. Glenn

See also **Delphi**.

Parnell, Charles Stewart (1846-1891), an Irish political leader, almost obtained *home rule* (self-government) for Ireland by constitutional means (see **Home rule**). But scandal ruined his career.

Parnell entered the British House of Commons in 1875 as a member for County Meath. He united Ireland's Home Rule Party, and tried to make it powerful by obstructing all other legislation until Irish demands were met. To unite Ireland, Parnell came to terms with Irish revolutionaries and supported the Land League. The league wanted land reforms that would result in tenant farmers owning their farms.



Brown Bros.

Charles Parnell

In 1879, Parnell visited the United States and collected large amounts of money for the Land League. When he returned to Ireland, he suggested boycotting the landlords to force land reform. For this policy and for trying to obstruct legislative proceedings, Parnell was arrested and imprisoned for six months. From prison, he urged tenant farmers not to pay rent. After his release in 1882, Parnell returned to Parliament and tried again to force home rule. For a time, he seemed about to succeed. In 1886, Parliament passed the Tenant's Relief Bill, which improved farmers' conditions.

But the next year, Parnell had to defend himself against charges that he was involved in the Phoenix Park murders. Irish terrorists had committed these murders in 1882. Parnell proved that letters which seemed to implicate him were forgeries.

In 1889, just as Parliament was about to meet, a political supporter of Parnell named Captain William O'Shea filed divorce proceedings against his wife because of her relationship with Parnell. The charges were proved, and Parnell's reputation and influence were ruined. Parnell married Katharine O'Shea after the divorce and lost his position as leader of the Home Rule Party. He later tried unsuccessfully to regain his political leadership.

Parnell was born on his family's estate of Avondale in County Wicklow. He was educated at Magdalene College of Cambridge University. Thomas E. Hachey

Parochial school, *puh ROH kee uhl,* is a private school conducted and supervised by a religious group. Many people think the term *parochial* means schools conducted by the Roman Catholic Church. But *parochial* comes from the Latin word for *parish* (church district) and refers to a school operated by any church. The name usually applies to elementary and high schools, but can also describe colleges and universities. Instruction in parochial schools includes religious education as well as many of the subjects taught in public schools. In the United States, parochial schools are the only schools allowed by law to require that teachers and staff hold particular religious beliefs.

The Roman Catholic school network grew rapidly in the 1800's and 1900's, becoming the largest parochial school system in the world. Registration in U.S. Catholic schools peaked in the mid-1960's, when 5 $\frac{1}{2}$ million students were enrolled. In the Roman Catholic system, a superintendent appointed by the bishop directs the parish schools. Many high schools are cooperatively directed and supported by several different parishes.

Protestant groups also operate a number of parochial schools. Many Protestant schools are *parent-controlled*—that is, run by an independent board of elected parents or association members, under the supervision of a congregation or religious body. Protestant denominations that administer schools include Baptists, Lutherans, and Episcopalians. In the late 1900's, schools run by evangelical Protestant groups grew rapidly. The Association of Christian Schools International is a large group representing a number of evangelical denominations. This association oversees several thousand schools, including more than 100 colleges.

The largest system of Jewish schools in the United States is the National Society for Hebrew Day Schools, also called Torah Umesorah. This society operates Orthodox schools. The Solomon Schechter Day School Association oversees conservative Jewish schools. Many other Jewish groups also maintain parochial schools.

Parochial schools operate with funds provided by the religious groups that administer them. Many such schools also charge students a fee called *tuition*. Some supporters of parochial education feel that parochial schools, like public schools, should also receive tax dollars. They argue that parochial education is a form of school choice for which parents should be given tax subsidies or credits. But the Supreme Court of the United States has ruled several times that laws providing tax funding for parochial education are unconstitutional. These rulings held that such funding violates the constitutional principle of separation of church and state because the schools endorse particular religious beliefs.

A related debate concerns whether parochial schools should be allowed to participate in a school choice plan called a *voucher system*. In a voucher system, families receive coupons called *vouchers*. Parents can use their vouchers to pay for their children to attend any public or private school in the program. Because vouchers are funded with taxes, some people feel that including parochial schools in voucher systems also violates the principle of separation between church and state. But in 2002, the U.S. Supreme Court ruled that voucher programs can include parochial schools without violating the Constitution of the United States. Stephen M. Fain

Parody is a comic imitation of a literary work. A writer creates a parody to ridicule the work of another by exaggerating that author's style or ideas. Parody is in literature what a cartoon is in art.

Parodists usually choose famous writers who have a distinctive style, so that the reader can easily recognize the subject of the parody. For example, the American authors Ernest Hemingway and Henry James have often been parodied. Parodists exaggerate Hemingway's crisp style and James's complicated sentences.

Expert parodists thoroughly know the subject they are parodying. A successful parody demonstrates not only the understanding of the original author but also the parodist's own skill. Although parody involves criticism, it is also a kind of appreciation. By selecting a certain author, the parodist acknowledges that the subject is both original and well known.

Many early English novelists began their careers as parodists, including Jane Austen, Henry Fielding, and William Makepeace Thackeray. Perhaps the leading American parodist of the mid-1900's was Peter De Vries. Almost all his novels have passages in which he parodies the work of others. H. George Hahn

See also **Humor** (Types of humor).

Parole is the early release of criminals from prison, in most cases as a reward for good behavior. A prisoner can be paroled only after serving part of his or her sentence. Parole is actually a continuation of a sentence away from prison, and paroled prisoners, called *parolees,* must follow certain rules. For example, they must get a job, support their family, and avoid liquor and other drugs. If parolees violate any of the rules, or if they commit another crime, they may be sent back to prison.

A parole board decides whether a criminal should be released. In the United States, parole boards are part of most state governments. A board considers such factors as the crime involved, the time already served, and the criminal's behavior in prison. Parolees are supervised by a parole officer for a certain period, depending on the sentence and the time served.

Parole has several purposes. Some criminal justice officials believe parolees have a better chance of becoming law-abiding citizens than criminals released without supervision. Parole also tries to protect society by preventing offenders from committing new crimes. Parole also costs society less than keeping people in jail.

In the late 1900's, many criminologists joined in criticizing parole. They believed it did not help prisoners readjust to society. They also thought the main purpose of prison should be to punish criminals, not to reform them. These critics charged that the parole system is unfair because criminals who commit the same crime may not have to spend the same length of time in prison. Some may be paroled sooner than others. By 1980, a number of states had abolished parole and substituted *fixed sentences*. Under this system, criminals must serve a specific amount of time in prison, depending on their crime. In 1984, Congress passed a law that abolished parole for federal prisoners.

Parole differs from probation. A judge may place a criminal on probation instead of sending him or her to prison. Criminals are paroled only after they have served time in prison. See **Probation**. James O. Finckenauer

Paroquet. See Parakeet.

Parotitis. See Mumps.

Parr, Catherine. See Henry VIII.

Parrakeet. See Parakeet.

Parris Island Marine Corps Recruit Depot, South Carolina, trains most United States Marine Corps recruits east of the Mississippi River. It also trains all women Marine recruits. The island, near Beaufort, covers 7,100 acres (2,900 hectares). Horse Island Bridge and causeways connect the island to the mainland. Alexander Parris, public treasurer of South Carolina in the 1700's, once owned the island. The Marines established their first post there in 1891.

Critically reviewed by the United States Marine Corps

Parrish, Maxfield (1870-1966), an American painter and illustrator, portrayed a world of rich color and poetic fancy. His travels in Italy and his later life among the New Hampshire mountains developed his love for romantic, idealized natural beauty. The towering peak of Ascutney, within sight of his home, is suggested in many of his works. An unusual shade of blue, which Parrish used in many of his pictures, came to be known as "Maxfield Parrish blue."

Parrish's posters, magazine covers, murals, and other decorations demonstrate his skillful draftsmanship and distinctively elegant style. The many books he illustrated include *Mother Goose in Prose, Knickerbocker's History of New York, The Arabian Nights, Wonder Book, Poems of Childhood, Golden Age,* and *Dream Days.* The rich and glowing colors that Parrish used in his works attracted many admirers.

Parrish was born in Philadelphia of Quaker parents. He graduated from Haverford College and later studied at the Pennsylvania Academy of the Fine Arts. He also studied under Howard Pyle at Drexel Institute of Art, Science and Industry (now known as Drexel University).

Charles P. Green

See also **Pied Piper of Hamelin** (picture).

Parrot is the name of a large group of colorful birds found chiefly in warm, tropical regions. They are popular as pets because they become affectionate and tame, and many can be taught to talk. Parrots range from about 3 inches (8 centimeters) to over 3 feet (90 centimeters) long. Most parrots have thick, hooked bills, and many have long tails. Parrots also possess short legs and feet with two toes pointing forward and two pointing backward. This arrangement of the toes is called *zygodactyl* (pronounced *zy guh DAK tuhl*). These strong, grasping feet enable parrots to grasp fruits and nuts, climb, and even hang acrobatically from tree branches. *Parakeet* is a general name for many kinds of small to medium-sized parrots, especially those with long, pointed tails.

Parrots are noisy, sociable birds that live chiefly in forested areas. Some parrots live in *savannas* (grassy, thinly wooded areas) and deserts. Parrots commonly eat fruits, nuts, seeds, and buds. Some also eat nectar and pollen.

Most parrots choose one mate for life. Female parrots lay round, white eggs. They deposit the eggs in holes in trees, on the ground, in cracks in rocks, or in holes dug in termite nests. The *monk parakeet* of Argentina builds a huge community nest out of sticks. Many pairs of monk parakeets share the nest, which provides a safe place to lay eggs and also protects the birds from cool weather. Other parrots may nest in artificial nest boxes placed in trees by people.

Kinds of parrots. There are about 350 species of parrots. About half live in Central and South America. Most of the rest live in Australia, New Guinea, and nearby Pacific islands. About 50 species live in Africa and southern Asia. The United States once had its own species of parrot, the *Carolina parakeet,* but it became extinct in about 1920 because of hunting and forest destruction. A rare species, the *thick-billed parrot,* lives in western Mexico and may wander into southern Arizona and New Mexico. The *Puerto Rican parrot* is an endangered species.

Parrots of South and Central America. The *macaws* are large parrots that live mainly in tropical lowland forests of South America. A few species live in Central America. Macaws have long, pointed tails and huge bills. The blue *Hyacinth macaw* is the world's largest parrot. It grows up to 39 inches (100 centimeters). *Amazons* are predominantly green parrots with big, chunky bodies and short, squared tails. Colorful spots adorn their wings and head. These birds live in treetops in the tropical forests. *Parakeets* and *conures* are small to medium-sized, mainly green parrots with long, pointed tails. *Parrotlets* are tiny parakeets with short tails.

Parrots of Australia and New Guinea. Cockatoos live in Australia, New Guinea, and nearby islands. They have large, thick bills. Most cockatoos are white with bushy crests of feathers on their heads. The *palm cockatoo* is a large, jet-black bird. It has a bare skin patch on its cheek, which may turn bright red when the bird is alarmed. The rose-colored *galah (guh LAH)* lives in large flocks in central Australia. The *cockatiel,* a long-tailed relative of cockatoos, commonly inhabits northern and central Australia.

Lories and *lorikeets* live mainly in wet forests in New Guinea, Australia, and nearby islands. They are small- to medium-sized parrots with black, red, or orange bills. Their bills are the longest and narrowest of any parrot, and they have brush-tipped tongues for gathering pollen and nectar. The tiny *pygmy parrots* of New Guinea have extremely long toes. They creep up tree trunks, like small woodpeckers, in the thick forest. The *budgerigar (buhj uhr ee GAHR),* from central Australia, is the best-known parakeet because of its popularity in zoos and as pets. The *rosellas,* found in coastal Australia, have bold patterns of blues, reds, and yellows on their bodies.

Parrots of New Zealand include some of the most unusual species. The large, chunky *kea* feeds on fruits and *grubs* (immature insects). It also eats dead animals it finds on the ground. The kea is popular with tourists because of its habit of perching on cars to beg for food. The large, forest-dwelling *kaka* has a long, strong beak that it often uses to tear apart dead wood in search of insects. The *kakapo,* or owl parrot, has an owllike face and cannot fly. Unlike most parrots, the bird is *nocturnal*—that is, it sleeps during the day and becomes active at night. The owl parrot is close to extinction because of mammal predators that people have introduced to New Zealand. These predators include rats, cats, and mongooses.

Parrots of Africa and southern Asia. Hanging parrots are tiny, mainly green parrots of southeastern Asia and the islands of Indonesia. Their name comes from their strange behavior of roosting upside down at night like bats. The *rose-ringed parakeet* lives in tropical Africa and southern Asia. It has a long tail, a bright red bill, and a bright green head. The nine species of *lovebirds* are small African parrots. They have short, rounded tails and rather large bills. They are called lovebirds because they use their bills to caress each other. The large *gray parrot,* from the west African rain forests, is a popular bird pet because it can learn to say words.

Parrots and people. People should keep parrots in clean, warm cages large enough so that the birds can exercise. Parrots need water, fresh air, and a variety of foods, including seeds, fruits, and vegetables, to stay



WORLD BOOK illustrations by Walter Linsenmaier

Rainbow lorikeet
Trichoglossus haematodus
Found from East Indies and Australia to Vanuatu
($\frac{1}{3}$ life size)

Scarlet macaw
Ara macao
Found from Mexico to Bolivia
($\frac{1}{3}$ life size)

Sulfur-crested cockatoo
Cacatua galerita
Found in Australia and New Guinea
($\frac{1}{3}$ life size)

Yellow-headed Amazon
Amazona ochrocephala
Found from Mexico to Ecuador and Brazil
($\frac{1}{4}$ life size)

healthy. When well cared for, parrots can live extremely long lives. Several kinds of large parrots are known to have lived for more than 50 years in captivity. Smaller species, such as parakeets, can live up to 20 or 30 years.

Parrots are among the most intelligent birds and can learn to solve fairly complex problems. Many species of parrots are prized for their ability to repeat words or to learn complicated tricks. The gray parrot can learn new phrases within hours of teaching. It even has been shown to use human words or other symbols to communicate feelings such as hunger, fear, or boredom.

Parrots may carry the disease *psittacosis,* also called *ornithosis,* which can be transmitted to people who handle infected birds or breathe dust contaminated with their droppings. Because of this disease, all parrots must be examined by a health officer before being shipped into the United States and some other countries.

Many parrots are in danger of extinction, largely because people have destroyed much of their habitat. Some dealers sell illegally captured wild parrots at high prices. People should buy parrots only from licensed dealers who sell birds that were bred in captivity.

John W. Fitzpatrick

Scientific classification. Most scientists classify parrots in their own family, Psittacidae, in the order Psittaciformes. However, many specialists now recognize three separate families, the Loriidae (lories and lorikeets), Cacatuidae (cockatoos and cockatiels), and Psittacidae (true parrots and parakeets).

Related articles in *World Book* include:

Cockatiel
Cockatoo
Kea
Lovebird
Macaw
Parakeet
Psittacosis

Parrot fever. See Psittacosis.

Parrotfish is the name of a group of about 75 species of fish that live around coral reefs in tropical and subtropical seas. They get their name from their unusual front teeth, which resemble a parrot's beak.

Parrotfish range in size from 4 inches (10 centimeters) to more than 4 feet (1.2 meters). They have thick bodies covered with large, thick scales. Most parrotfish are brightly colored, and most change color during their lifetime. In some species, a fish born female will later become a male.

Parrotfish feed mostly on algae, which they scrape off rocks and corals with their strong teeth. Many parrotfish feed on sea grasses around coral reefs, often grazing in large schools. The *queen parrotfish,* which lives in tropical parts of the western Atlantic, sometimes grazes in groups of three or four females and one male. Parrotfish eat during the day and rest at night. Many species of parrotfish form a thin, transparent, cocoonlike covering around themselves at night and rest in it until daylight.

Tomio Iwamoto

Scientific classification. Parrotfish are in the family Scaridae. The scientific name for the queen parrotfish is *Scarus vetula.*



WORLD BOOK illustration by John F. Eggert

The queen parrotfish lives in the western Atlantic.

Parry, Sir William Edward (1790-1855), a British naval officer and Arctic explorer, led official expeditions in 1819, 1821, and 1824 in search of the Northwest Passage. Parry discovered Melville Island on one of these voyages (see **Melville Island**).



Detail of an oil painting on canvas (1820) by Samuel Drummond; P. E. Parry, Furneu Pelham, Hertfordshire, England (Derek Bayes)

Sir William Edward Parry

In 1827, Parry sailed in his ship *Hecla* in an attempt to reach the North Pole by way of Spitsbergen. At Trurenberg Bay, he and his party left the ship and started north. The 28 members of the expedition took two boats and enough supplies for about 70 days. Steel runners attached to the boats enabled them to travel on the ice as well as to sail on the water. The expedition reached 82°45′ north latitude, within 500 miles (800 kilometers) of the North Pole. It was the farthest north any explorer had gone until then and remained a record until 1876.

Parry described his travels in *Voyage for the Discovery of a Northwest Passage* (1821) and *Narrative of an Attempt to Reach the North Pole in Boats* (1828). He was born in Bath, England. Barry M. Gough

Parsley, *PAHRS lee* or *PAHR slee,* is a biennial vegetable, sometimes considered as an herb. It is closely related to caraway. The most popular variety produces a low-growing rosette of finely curled and crumpled green leaves. Another variety of parsley produces plain



WORLD BOOK illustration by Jill Coombs

Parsley is a garden vegetable. The most popular variety produces clusters of finely curled and crumpled green leaves.

leaves. The fresh leaves are used mainly to decorate meat dishes and salads. The leaves of parsley can also be dried and used in soups.

A special kind of parsley grown in Germany, and occasionally in America, is called Hamburg parsley. This plant produces a long root that may be stored for winter use. Hamburg parsley is used as a soup flavoring.

Parsley is an excellent source of all vitamins. It is especially rich in vitamins A and C and in the minerals iron and calcium. But it is usually eaten in such small quantities that it has little effect on a person's health.

Parsley seed is sown in greenhouses, hotbeds, or open beds. It sends up leaves slowly and unevenly. The plants are moved to the garden about a week before the last spring frost. From 6 to 10 plants are enough for a family. A few leaves at a time are picked off the plant. Sometimes parsley plants are potted and grown indoors in a sunny window during winter.

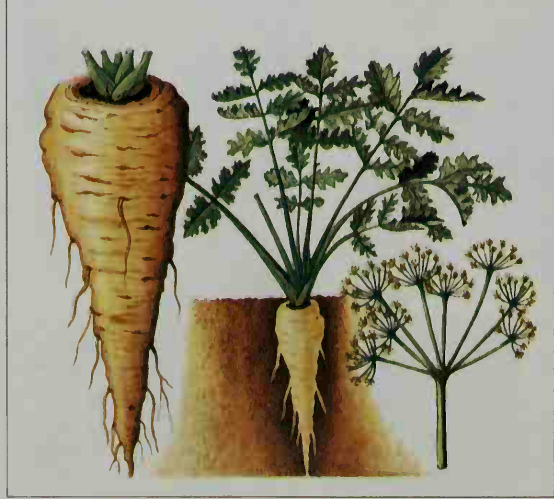
Parsley was first grown in Sardinia and southern Italy. Early Romans used parsley to fashion garlands that crowned their military heroes and athletic heroes.

Albert Liptay

Scientific classification. Parsley belongs to the parsley family, Apiaceae or Umbelliferae. It is classified as *Petroselinum crispum.*

Parsnip is a biennial vegetable with many deeply and finely lobed leaves. The edible part of the parsnip is the plant's long tapering white root. Parsnips are a common plant in home gardens, but they have little commercial importance. Parsnips are related to carrots and dill.

The parsnip grows best in a deep rich soil. The seeds must be sown in early spring. The plants come up slowly and unevenly. A few radish seeds are usually mixed with the parsnip seeds. The radishes come up quickly and mark the rows of parsnips so they can be cultivated. If parsnips are neglected they can become troublesome weeds, as wild parsnips are. Parsnip roots grow slowly until the cool weather of fall. Then they grow rapidly. Parsnip roots are not injured by freezing, and are often left in the ground over winter.



WORLD BOOK illustration by Jill Coombs

The parsnip is a garden vegetable. The edible part of the plant is its long tapering white root, which resembles a carrot.

Parsnips are usually free from insect enemies and suffer from few diseases. The parsnip provides moderate amounts of vitamins and minerals. Its calorie level is similar to that of the potato.

The parsnip is native to the Rhine Valley in Europe. It was known and probably used as food early in the Christian Era. It was cultivated in England in 1592 and was grown in New York by 1806. Albert Liptay

Scientific classification. Parsnips belong to the parsley family, Apiaceae or Umbelliferae. It is classified as *Pastinaca sativa.*

See also Cow parsnip.

Parsons, Elsie Clews (1875-1941), was an American cultural anthropologist. She studied the cultures of Indian groups in North, Central, and South America. She also recorded folk tales of black peoples of North America and the West Indies.

In all her studies, Parsons emphasized the effect of contact between different cultures. In 1915, she traveled to the Southwestern United States, where she first studied American Indians in their natural environment. She recorded specific data on these cultures and included accounts of their customs, folklore, and rituals. Parsons wrote numerous books, including *Mitla: Town of the Souls* (1936) and *Pueblo Indian Religion* (1939).

From 1918 until her death, Parsons served as assistant editor of the *Journal of American Folklore.* In 1940, she became the first woman elected president of the American Anthropological Association.

Parsons was born in New York City. She received a Ph.D. degree in sociology from Columbia University in 1899. Nancy Oestreich Lurie

Parsons, Talcott (1902-1979), was an American sociologist. He is considered the most important theorist of the sociological school of thought called *structural-functionalism.* This school stressed the importance of social status and institutions in a society (see **Sociology** [Development of social research]).

Parsons regarded society as a system whose parts fit together and function to maintain the stability of the society. According to Parsons, every society has three parts: (1) the individual, (2) the relationships among many individuals, and (3) the society's culture in general. Any change in one part causes a reaction in and from the other parts.

Parsons was born in Colorado Springs, Colorado, and graduated from Amherst College in 1924. He later studied at the London School of Economics and Political Science and, in 1927, he received a doctorate from the University of Heidelberg in Germany. Parsons taught at Harvard University from 1927 to 1973. Parsons's books include *The Structure of Social Action* (1937) and *The Social System* (1951). Neil J. Smelser

Parthenon, *PAHR thuh nahn,* is an ancient Greek temple in Athens. The temple stands on a hill called the *Acropolis* overlooking the city. The Parthenon was dedicated to Athena, the city's patron goddess. It is probably the best example of ancient Greek architecture.

The Greeks erected the Parthenon between 447 and 432 B.C. The temple was designed by the Greek architects Ictinus and Callicrates. The Greek sculptor Phidias designed the sculptural decoration for the building. The Parthenon became a Christian church about A.D. 500. After Turkish Muslim forces captured the city, in the mid-1400's, the Parthenon served as a mosque.



The Parthenon is an ancient Greek temple in Athens that was built to honor Athena, the patron goddess of the city. It was constructed entirely of white marble.

Warren Churg, Art Resource

In 1687, the Parthenon was badly damaged when the /enetians tried to conquer Athens. The Turks were us- ng it for storing gunpowder, which exploded and vrecked the central part of the building. The remaining culpture has since been moved to the Acropolis Muse- ım in Athens and the British Museum in London (see Elgin Marbles). Today, only ruins of the building remain.

The Parthenon was built entirely of *Pentelic marble,* a vhite marble that was brought from Mount Pentelicus 1 miles (18 kilometers) from Athens. The temple is a rec- angular building that measures 237 feet (72 meters) long ınd 110 feet (34 meters) wide. It stands about 60 feet (18 neters) high.

The Parthenon contains a central enclosed space, alled a *cella,* which is divided into two rooms. One of he rooms once contained a huge gold and ivory statue of Athena, and the other room once served as a treasury. A total of 46 Doric columns surround the cella (see Column [The Doric column]).

Brightly painted sculpture originally decorated the Parthenon. Sculptures once filled the two *pediments* (tri- ngular ends of the roof). The eastern pediment was lecorated with scenes showing the birth of Athena. The vestern pediment showed the battle between Athena nd the sea god Poseidon for the control of Athens.

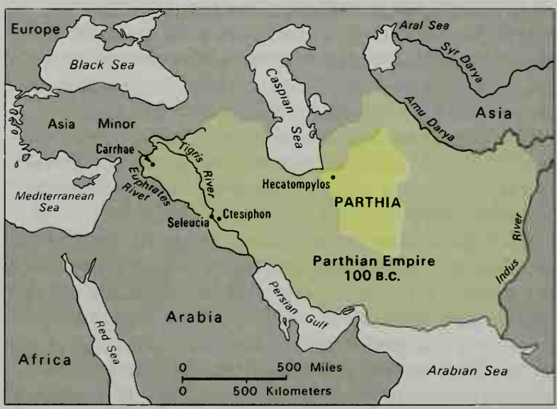
Around the top of the outer wall above the columns of he Parthenon was a series of small sculptured panels alled *metopes.* The metopes showed famous mytholog- cal battles between the Lapiths and the centaurs, the ods and a race of giants, and Greeks and Amazons. These sculptured panels also presented battle scenes rom the Trojan War. Along the outer wall of the cella vas a continuous horizontal *frieze* (decorated band). The rieze showed the people of Athens, including Athenian fficials, priests, maidens, and young men on horseback, n the annual procession honoring the birthday of Athena. Restoration work on the Parthenon began in 1986. William J. Hennessey

See also **Acropolis; Greece, Ancient** (picture: The Parthenon); **Phidias.**

Parthia, *PAHR thee uh,* was an ancient kingdom south- east of the Caspian Sea, in Asia. Parthians lived a simple life and were noted as warriors. Hecatompylos was the capital of Parthia.

The Parthians were independent until the 500's B.C., when Cyrus the Great of Persia conquered them. Alexander the Great also conquered Parthia, and it later became part of the Seleucid kingdom. By 235 B.C., Parthia had regained its independence, and it soon ruled a large empire in the East.

Parthia fought several wars against the Romans, de- feating Crassus in 53 B.C. and Mark Antony in 36 B.C. and losing to Trajan in A.D. 116. A Persian revolt overthrew the Parthian rulers about 226, and Parthia later became a part of the Sassanid Empire that was founded by Ardashir I. Thomas W. Africa



WORLD BOOK map

Parthia was an ancient kingdom in Asia. It began to expand about 235 B.C. and soon ruled a large empire in the East.

Parti Québécois, *pahr TEE kay beh KWAH,* is a politi- cal party in Quebec, the largely French-speaking prov- ince within mainly English-speaking Canada. The Parti Québécois, often called the PQ, calls for Quebec to sep- arate from Canada and become an independent nation.

The Parti Québécois was founded in 1968 with René Lévesque, a member of Quebec's legislature, as its first leader. The party gained control of the provincial legisla- ture in elections held in 1976. In 1980, the PQ conducted a referendum on whether to open discussion with the federal government of Canada concerning what was called *sovereignty association* between Quebec and Canada. Such an association would have given Quebec political independence while maintaining its economic ties to Canada. The referendum was decisively defeated.

The PQ lost control of the legislature in 1985 but regained power in 1994. In 1995, the people of Quebec voted on another referendum backed by the PQ. The referendum proposed sovereignty for Quebec but suggested the possibility of a special economic and political relationship between an independent Quebec and Canada. It was narrowly defeated. J. L. Granatstein

Participle is a verb form used as an adjective without losing its character as a verb. Like a verb, a participle may have an object or an adverbial modifier.

A word can often be identified as a participle only because it takes an object. In the sentence *The shouting mob, hurling stones, moved forward,* the word *shouting* is an adjective that modifies *mob.* The word *hurling* also modifies *mob,* but it is a participle because it has an object, *stones.*

A verb has two participles in the active voice. The present participle—for example, *drawing*—expresses action in progress. The past participle, *drawn,* expresses finished action. The perfect participle, *having drawn,* is a modified form. The participle forms in the passive voice are *being drawn* for the present tense, *drawn* for the past tense, and *having been drawn* for the perfect tense.

A present participle used as a noun is called a *gerund.* Gerunds, even though they function as nouns, keep the characteristics of a verb. In the sentence *Talking nonsense is sometimes fun,* the word *Talking* is the subject of *is,* but *nonsense* is the object of the gerund. In *By talking good sense, he won respect,* the word *talking* is the object of a preposition. Patricia A. Moody

Particle, Subatomic. See Subatomic particle.

Particle accelerator is a device that speeds up the movement of tiny bits of matter. These particles are either *ions* (electrically charged atoms) or electrically charged *subatomic particles,* objects that are smaller than an atom. The particles travel through an accelerator in a narrow beam. In accelerating the beam, the machine increases the particles' energy of motion.

Uses of accelerators. Physicists use accelerators to discover and study subatomic particles and the forces that govern them. The accelerator forces beams of subatomic particles such as positively charged protons or negatively charged electrons to strike a stationary target or to collide with another beam that is moving in the opposite direction. The resulting impacts break particles away from the target or cause other subatomic particles to form. Devices called *particle detectors* located near the points of impact provide information about particles that fly away from these points.

Other scientists use accelerators to create and study atoms of chemical elements that are heavier than uranium, the heaviest natural element. In this case, nuclei (singular, *nucleus*) in beams of ions combine with target nuclei to form heavy elements. The nucleus is the dense, core region of an atom, consisting of protons and electrically neutral neutrons.

Still other researchers accelerate beams to probe the structure of the atomic nucleus. Because some accelerator experiments break away pieces of nuclei, the machines are sometimes called *atom smashers.*

Researchers in industry and other areas use intense X rays produced by special electron accelerators. A beam of electrons sends out X rays when it passes through a *magnetic field,* a region of space in which a moving electric charge is acted on by magnetic force. One use of these rays is to produce transistors on experimental computer chips.

Physicians use particle beams to destroy tissue in cancerous tumors. Doctors also use X rays generated by accelerators to diagnose and treat cancer.

How accelerators work. Accelerators use electric force to speed up electrically charged particles. To prevent loss of energy from collisions with air molecules, the particles travel through pipes from which almost all the air has been pumped.

Physicists measure the energy of accelerated particles in *electronvolts* (eV). One electronvolt is the amount of energy gained by an electron as it moves freely through a potential difference of 1 volt. Accelerators can produce particles with energy in the range of thousands of electronvolts (keV), millions of electronvolts (MeV), billions of electronvolts (GeV), or trillions of electronvolts (TeV).

Accelerators have two basic shapes. In a *linear accelerator,* the beam travels in a straight line. In a *circular accelerator,* the particles travel in a nearly circular path. This article describes the main kinds of accelerators.

The Cockcroft-Walton accelerator, a linear machine, was the first accelerator to break up atomic nuclei. Physicists John D. Cockcroft of Britain and Ernest T. S. Walton of Ireland invented this machine in 1929. In 1932, they used it to accelerate protons to 500 keV and break up nuclei. Today's machines speed up protons, electrons, and ions. Most of them serve as beam sources for more powerful accelerators.

A Cockcroft-Walton accelerator has a long pipe with an *electrode* (electric terminal) at one end. This electrode receives a high voltage of the same kind—positive or negative—as the particles to be accelerated. At the other end is an electrode whose voltage is zero. This electrode has a hole through its center and is connected to the first electrode by a tube that carries the beam.

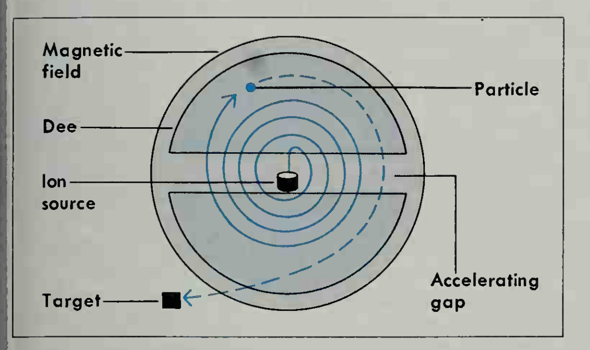
The machine releases the particles to be accelerated near the charged electrode. The voltage in this electrode repels these particles. The particles fly through the tube and pass through the hole. A Cockcroft-Walton accelerator can boost particles to about 750 keV.

The Van de Graaff generator can accelerate protons, electrons, and ions to about 15 MeV. United States physicist Robert J. Van de Graaff built his first high energy accelerator in 1931. Hundreds of such accelerators have been built, more than all other types combined.

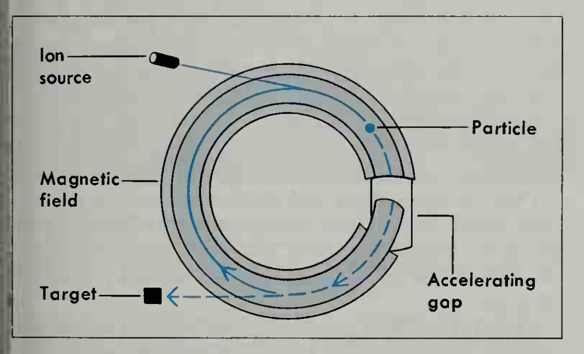
The machine has a hollow metal sphere mounted at one end of a pipe. A belt runs over a pulley located beside a source of electric charge and a pulley next to the sphere. The source puts a charge on the belt. A metallic brush transfers the charge to the sphere. When the charge on the sphere builds to a certain strength, particles that have the same kind of charge—positive or negative—are released near the sphere's inner surface. These particles plunge to the other end of the machine, pass through a hole, and strike a target.

The tandem Van de Graaff generator has a sphere located at the center of a long pipe. The sphere receives a positive charge. This charge attracts negative ions that are inserted at one end of the pipe. When the ions reach the center, they pass through a thin target that removes two electrons from some of them. The loss of electrons makes these ions positive, so the sphere repels them to-

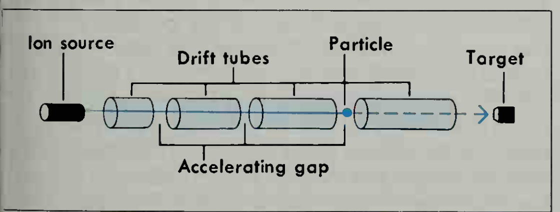
How particle accelerators work



In a cyclotron, a particle is drawn out from an ion source by one of the semicircular electrodes called *dees.* A magnetic field causes the particle to travel in a circular path. Each time the particle crosses an accelerating gap, it receives an energy boost and moves outward until it collides with a target.



In a synchrotron, a particle is bent by a magnetic field to move in a fixed circular orbit. As the particle gains energy, the magnetic field grows stronger to keep it moving on the same path. After crossing an accelerating gap a number of times, the particle reaches its peak energy and is guided to a target.



WORLD BOOK diagrams by Art Grebetz

In a standing-wave linear accelerator, a particle moves in a straight line through a series of drift tubes. As the particle passes through accelerating gaps between the tubes, it gains speed and builds up energy. The tubes enable the particle to maintain its speed so it will strike a target with maximum force.

ward the other end of the pipe. They gain additional energy as they fly to the end of the pipe. A tandem machine can produce ions with twice the energy of a single Van de Graaff generator.

The standing-wave linear accelerator boosts protons to energies up to 200 MeV by generating an alternating *electric field.* The field is part of an electromagnetic wave produced by vacuum tubes called *klystrons.* The wave, called a *standing wave,* extends the length of a horizontal pipe and vibrates across the pipe's width.

Along the length of the pipe, the field alternates between positive and negative. When the field is positive, it accelerates the protons in the desired direction. But when it is negative, it tends to accelerate them in the opposite direction.

The field does not actually accelerate protons the "wrong way," however, because the accelerator contains metal *drift tubes* that block the field. The tubes are installed end-to-end the length of the pipe, with gaps between them. The vibration of the wave is timed so that the protons are inside the tubes when the field would accelerate the protons the "wrong way."

The traveling-wave linear accelerator speeds up electrons. A wave generated by klystrons travels the length of a horizontal pipe. The electrons travel with the wave's negative field, gaining energy as they go—much as a surfer rides an ocean wave. The electrons move so quickly that the positive field cannot catch up with them, so the accelerator needs no drift tubes.

The longest linear accelerator in the world is a traveling-wave device at Stanford Linear Accelerator Center (SLAC) in Palo Alto, Calif. This machine, which began operating in 1966, is 2 miles (3.2 kilometers) long. In the late 1980's, SLAC added a circular structure to one end of the machine, enabling it to operate as a two-beam collider. In this case, the machine accelerates a beam of electrons and a beam of *positrons,* each with an energy of up to 50 GeV. A positron is a form of antimatter—a positively charged counterpart of an electron. In a head-on collision of a matter particle and its antimatter counterpart, all the mass in the two particles turns into energy. An instant later, most of the energy turns into new particles.

The cyclotron is the simplest circular accelerator. American physicist Ernest O. Lawrence invented the cyclotron in 1930. He received the 1939 Nobel Prize for physics for this achievement.

In a cyclotron, the particles travel in a vacuum chamber located between the poles of an electromagnet. The chamber also contains two hollow, D-shaped electrodes, mounted with their straight sides facing each other and a gap between them. The cyclotron generates an alternating electric field across the gap.

Charged particles are released at the center of the machine. The electric field accelerates them into one of the electrodes. The electromagnet generates a magnetic field that makes the particles follow a spiral path leading back to the gap. By the time they arrive, the electric field has reversed itself, so the particles are accelerated across the gap in the opposite direction. Again, the particles follow a spiral path and are accelerated across the gap. This process continues until the particles hit a target or spiral out of the cyclotron.

The energy of particles in a cyclotron is limited by the diameter of the magnet and the strength of the magnetic field. The largest cyclotron ever built could accelerate protons to 720 MeV.

The synchrotron reaches higher energies by guiding particles along a racetracklike path of alternating straight and curved sections. At each curved section, one or more electromagnets bends the beam through only a relatively small arc. The particles follow the same path over and over. At one or more of the straight sections, the particles pass through a linear accelerator that

gives them a boost. As the particles gain speed, the synchrotron automatically increases the magnetic field to hold them on course.

The world's most powerful accelerator is a synchrotron at the Fermi National Accelerator Laboratory (Fermilab) near Batavia, Illinois. This machine lies in a tunnel that measures 3 $\frac{9}{10}$ miles (6.3 kilometers) in circumference. In 1972, its first year of operation, the machine accelerated protons to 400 GeV. Since 1987, it has collided beams of protons with beams of antiprotons, antimatter counterparts of protons. Each beam can reach an energy of about 980 GeV.

In January 1993, digging began for what would have been the largest and most powerful accelerator ever built, the Superconducting Supercollider (SSC). The tunnel, near Waxahachie, Texas, would have been 54 miles (87 kilometers) in circumference. The SSC would have collided two proton beams, each with an energy up to 20 TeV. In the fall of 1993, the United States Congress canceled the SSC as a cost-cutting measure.

The world's longest accelerator tunnel is located at the CERN research center near Geneva, Switzerland. The tunnel measures 17 miles (27 kilometers) around. It housed an accelerator called the Large Electron-Positron (LEP) collider when it began operating in 1989. In 1996, CERN scientists changed its name to LEP2 to reflect a major increase in beam energy. LEP2 collided electrons and positrons at energies up to 104.5 GeV per beam.

CERN shut down LEP2 in 2000 so that construction could begin on another accelerator in the same tunnel. The new machine, the Large Hadron Collider (LHC), would collide two beams of protons at energies up to 7 TeV per beam. Also in 2000, a machine called the Relativistic Heavy Ion Collider (RHIC) began operating at Brookhaven National Laboratory on Long Island, New York. The RHIC accelerates gold ions through two tubes that are 2.4 miles (3.8 kilometers) in circumference. The machine is designed to operate at energies up to 100 GeV per proton or neutron. Robert H. March

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Particle detector
Radiochemistry
Subatomic particle
Synchrotron
Van de Graaff generator
Walton, Ernest, T. S.

Particle detector is a device that physicists use to observe *subatomic particles,* units of matter smaller than an atom. Most particle detectors are installed in large machines called *particle accelerators.* An accelerator speeds up a beam of subatomic particles to almost the speed of light. It then directs the beam into a stationary target or forces it to collide with a beam moving in the opposite direction. The resulting impacts produce other subatomic particles. Detectors near the impact points reveal details about the mass, energy, electric charge, and other properties of the particles.

Physicists have conducted experiments with particle accelerators and detectors since the early 1930's. Scientists also use particle detectors to study *cosmic rays,* subatomic particles that originate in outer space.

How particle detectors work

All particle detectors work by recording transfers of energy. Subatomic particles transfer this energy to atoms that are part of the particle detector.

A particle that carries an electric charge transfers small amounts of its energy electrically. As the particle moves through the detector, its charge interacts with charges in atoms of the detector. The resulting changes in the atoms trace out the path of the particle.

Certain particles cannot transfer energy electrically. The neutrino, for example, cannot do so because it carries no electric charge; and the neutron has internal electric charges that cancel one another. Such particles do, however, interact nonelectrically with atoms in the detector. These interactions produce charged particles that then transfer energy electrically. By studying these secondary particles, physicists can determine properties of the uncharged particles.

Photographic materials and devices called *cloud chambers, bubble chambers,* and *spark chambers* detected particles in early accelerators, but are not used in modern machines. Instead, today's accelerators use *tracking chambers, sampling calorimeters, scintillators,* and combined systems of detectors.

Types of particle detectors

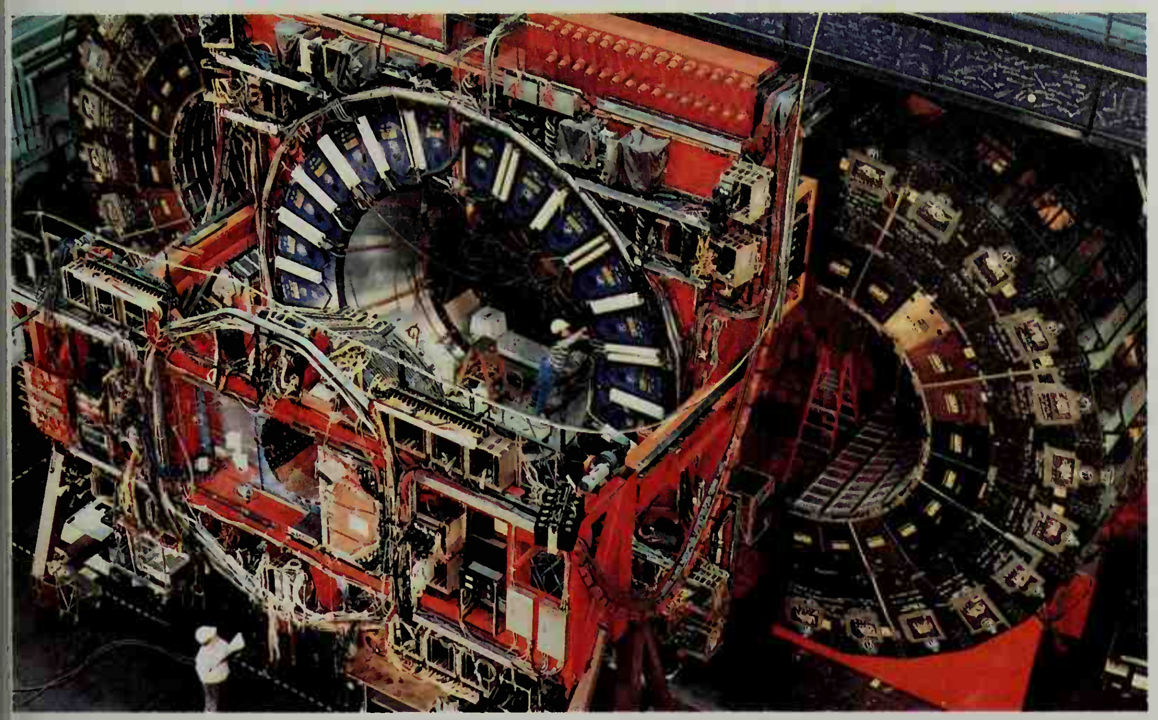
Photographic films and plates were among the earliest particle detectors. A particle passing through a photographic material "exposed" the material. Developing the film revealed the place where the particle passed through.

Cloud chambers used an *ion trail* left by a subatomic particle passing through a gas. The particle created this trail by transferring energy to *electrons* in the gas. An electron is a negatively charged particle that orbits an atomic nucleus. When a particle transfers a certain amount of energy to an electron orbiting a nucleus, the electron leaves its orbit. An atom's negative charges are usually balanced by an equal number of positive charges. So when an electron leaves its orbit, it leaves behind a positively charged atom—that is, a positive ion.

British physicist Charles T. R. Wilson invented the cloud chamber in 1911. In his invention, which became known as the *Wilson cloud chamber,* a container held a mixture of a gas and a vapor. Vapor condensed around the ions in the ion trail to form droplets. The droplets were visible as streaks that represented the particle paths, and were photographed.

Bubble chambers caused a subatomic particle to produce a trail of small gas bubbles in a liquid. The liquid was first heated above its boiling point, but held under high pressure to prevent it from boiling. The pressure was then reduced rapidly so the liquid would boil at the slightest disturbance. Subatomic particles disturbed the liquid, causing gas bubbles to form along their paths. Donald A. Glaser, an American physicist, invented the bubble chamber in 1952. He won the 1960 Nobel Prize for physics for this invention.

Spark chambers caused an electrical discharge, somewhat like a small lightning strike, along an ion trail produced by a particle. A spark chamber was a box containing a series of thin metal plates mounted parallel to one another. The chamber was filled with neon gas or



Fermilab Visual Media Services

A particle detector helps scientists study subatomic particles. Physicists at the Fermi National Accelerator Laboratory near Batavia, Ill., use this detector to record information about particles produced in collisions between beams of protons and beams of antiprotons.

another *noble gas* (a gas that does not normally react with other substances). The gas atoms that were ionized could conduct electric current, but the normal atoms could not.

To detect a particle, the chamber applied voltage to the plates. As a result, current in the form of sparks jumped from plate to plate along the particle path. Japanese physicists Shuji Fukui and Sigenori Miyamoto built the first practical spark chamber in 1959.

Tracking chambers trace particle paths by producing an electric signal, rather than a visible trail. Some of these detectors use an electric field to gather ions generated by subatomic particles onto a wire, a strip, or a pad. The ions produce pulses of electric charge. Electronic circuits enlarge the pulses so that they can be measured and recorded as digital data on magnetic tape. Georges Charpak, a Polish-born French physicist, received the 1992 Nobel Prize for physics for his invention of the multiwire proportional chamber, the first modern tracking chamber.

Sampling calorimeters collect ions produced by a subatomic particle as it passes through a gas or, more commonly, a liquid. The main use of a sampling calorimeter is to determine a particle's energy of motion, rather than to determine its position extremely accurately—as a tracking chamber does. This detector is based on a relationship between energy of motion and ionization: The number of ions collected for a particle that stops within the detector is approximately proportional to the particle's energy of motion.

Scintillators produce light when particles transfer energy to them. The light, in turn, strikes devices called *phototubes* or *photodiodes,* which then produce electric signals.

Scientists often build particle detectors between or around the poles of an electromagnet. The magnet causes charged particles to move along curved paths. From these curves, scientists can determine the momentum of particles.

Combined systems. Modern detectors are usually arranged in groups that work together. A combined system can measure properties of hundreds of subatomic particles at the same time. Physicists need such systems because modern accelerators commonly produce hundreds of particles in a single interaction. Generally, scientists can understand the interaction only by measuring a large number of these particles.

The number of interactions occurring in a combined system is often so large that only a small fraction of them can be recorded. The selection of interactions to record and the interpretation of the recorded data require tremendous amounts of computing.

A combined system may weigh thousands of tons and cost tens of millions of dollars to build. It may fill a large room and contain hundreds of thousands of individual wires, scintillators, and other components. It may take hundreds of physicists 10 years or more to design and build a large detector and to use it to gather and analyze data. Bruce G. Gibbard

See also Particle accelerator; Subatomic particle.

Particle physics. See Subatomic particle.

Partisans, *PAHR tuh zuhnz,* work behind enemy lines in wartime to weaken the opponent's hold on its homeland, and to support the military operations of their al-

lies. They perform reconnaissance and sabotage, and disturb enemy movements as much as possible. Partisans do not belong to the regular army but usually operate under a professional military commander or under the orders of a regular military force. See also **Guerrilla warfare; Underground.** Stephen Goode

Partnership is an association formed by two or more people to carry on a business. The people usually agree either in writing or verbally to become partners. But people who run a business together and share the profits are usually considered partners, even if they do not intend to be.

Rights and responsibilities of partners. All partners have equal rights and obligations in running the business, unless they have agreed on another arrangement. Any disagreement that arises among them is decided by majority vote. Each partner is an *agent* for the other partners. Ordinarily, therefore, anything a partner does that seems to be carrying on the business in the usual way is binding on the other partners.

All partners share in the profits of the business, but they do not necessarily share equally. The size of each share is agreed upon when the partnership is set up. It depends on how much money or property each contributes to get the business started, and on the kind and amount of work each partner is to do. Every partner is expected to devote time to the business. If one does more work than the others, the partners may agree to pay that person a salary as well as a share of the profits. Unless a system for sharing the debts of the partnership is set up formally, partners share their debts equally.

All the partners must be faithful to one another in their business dealings. No partner may enter into a transaction in the same line of business as the partnership without sharing the profits with the other partners. Neither may any partner use the funds or property of the partnership as his or her own.

All partners are liable for any debts acquired by the business. These debts are normally paid out of funds or property belonging to the business. If they cannot be paid in this way, any other property of a partner can be taken by the people to whom the debt is owed. A person can lose much money by belonging to a partnership that fails. To avoid such loss, many states allow *limited partnerships*. A *limited partner* may not take an active part in running the business, but is liable only for the amount of money he or she has invested. If a person wants to take part in running a business and still not risk losing more than he or she has invested, that person must form a corporation. See **Corporation.**

Changing or ending a partnership. No new partner may join the partnership without the consent of all the members. A new agreement must then be made, stating what the new partner must contribute and what will be his or her share of the profits. A person who wishes to leave the business can agree with the other partners on a price for buying him or her out. If the partners cannot agree, that person may have the business closed out and the property sold in order to take his or her share in cash. When a partner dies, the people who are named to handle the estate have the same rights.

Under the law, all partners are co-owners of the property belonging to the business. The Uniform Partnership Act, which is in force in most states, permits a partner to sell his or her interest in the partnership, but not in a particular piece of property. Similarly, people to whom a partner owes money may seize that partner's interest in the business, but not in any one piece of property. When a partner sells his or her interest, or when creditors seize it, the buyer or creditors can collect that partner's share of the profits, but they cannot help run the business. Robert B. Carson

Parton, Dolly (1946-), is a popular country music singer and songwriter known for her expressive songs, lilting voice, and striking stage appearance. She is also a motion-picture actress and successful businesswoman who runs her own music publishing and film production companies.

Parton has starred in a number of movies, including *Nine to Five* (1980) and *Steel Magnolias* (1989). She has composed many of her biggest hit songs, such as "Jolene," "Coat of Many Colors," "Two Doors Down," "Here You Come Again," "I Will Always Love You," and "Nine to Five." In 1986, she opened the Dollywood theme park in Pigeon Forge, Tennessee. In 2001, Parton won the Grammy award for best bluegrass album of the year for *The Grass Is Blue.*



AP/Wide World

Dolly Parton

Dolly Rebecca Parton was born in Sevier County, Tennessee. Many of her songs lovingly recall her childhood in the Great Smoky Mountains. From 1967 to 1974, she performed with country music singer Porter Wagoner in concerts and on his television series. The two recorded a series of hit duets. After Parton left Wagoner, she broadened her appeal by emphasizing more pop music material. Lydia Dixon Harden

See also **Country music** (picture).

Partridge, *PAHR trihj,* is the bird that people in the northern and western parts of the United States call *quail,* or *bobwhite.* It is known to many Southerners as



WORLD BOOK illustration by Trevor Boyer, Linden Artists Ltd

The gray partridge is a popular game bird in the open farmlands and prairies of Canada and the United States.

partridge. New Englanders use the term *partridge* for the *ruffed grouse.* Canadians call the *spruce grouse* the *swamp partridge* or *spruce partridge.*

However, scientists consider about 150 kinds of birds in the Eastern Hemisphere to be true partridges. The *gray partridge* is typical of this group. It has been imported into America in large numbers for breeding purposes. It is also known as the *Hungarian partridge* or *common partridge.* This bird lives throughout Europe and in northern Africa and western Asia.

The gray partridge may grow to 1 foot (30 centimeters) long. The upper body parts are ashy-gray with brown and black markings. Often there is a crescent-shaped spot of deep chestnut on the breast. The bird eats grains, tender plant shoots, and insects. It builds its nest on the ground. The female lays from 8 to 20 eggs. The gray partridge is an important game bird in the northwestern United States and the Prairie Provinces of Canada. The *chukar,* another type of partridge, is native to Asia and Europe. It also is important in the Northwest.

Donald F. Bruning

Scientific classification. Partridges belong to the subfamily Phasianinae in the family Phasianidae. The scientific name of the gray partridge is *Perdix perdix.* The chukar is *Alectoris chukar.*

See also **Bird** (picture: How birds feed); **Quail; Ruffed grouse.**

Parts of speech are the word categories of languages. Words belong to the same category if they show the same formal features or if they share a common function or position in a sentence. Both *table* and *man* are nouns because they show the possessive form *(table's, man's)* and by inflection. Both *table* and *man* can also fill a position in a sentence like "The ______ is big." Nouns, verbs, adjectives, and adverbs can be defined by formal features, function, and position. Other parts of speech, such as prepositions and conjunctions, have no formal features. They can be defined by their function and position in a sentence.

Parts of speech were originally based on individual words. Often a multiword phrase or clause served the same function as a part of speech. For example, a prepositional phrase may act like an adverb. Compare "Mary slept *late* yesterday" and "Mary slept *until noon* yesterday." The parts of speech are not rigid categories. Scholars disagree as to whether the first word in noun-noun compounds such as *television set* is a noun or an adjective. Also, new words are often constructed by shifting categories. For example, shortly after microwave ovens became available, the verb *to microwave* appeared in sentences such as *John microwaved the frozen rolls.*

Scholars differ on how to describe parts of speech. The traditional description lists eight classes: nouns, pronouns, verbs, adjectives, adverbs, prepositions, conjunctions, and interjections. Some scholars prefer to distinguish *form classes*—nouns, verbs, adjectives, and adverbs—from *function words*—prepositions, determiners, auxiliaries, and conjunctions. Others distinguish *inflected classes* from all other words, called *particles.* In addition, parts of speech were originally based on classical European languages and may not be adequate for describing all of the world's languages. Susan M. Gass

See the separate articles on each part of speech, such as **Adjective.** See also **Article.**

Parvovirus. See **Canine parvovirus.**

Pasadena, *pas uh DEE nuh,* California (pop. 133,936), is an attractive residential city. It is nationally famous as the home of the Rose Bowl, where two top college football teams play on New Year's Day or January 2. The Tournament of Roses includes a colorful parade (see **California** [picture: New Year's Day Rose Parade]). Pasadena is at the base of the San Gabriel Mountains, overlooking the San Gabriel Valley. It is about 10 miles (16 kilometers) north of Los Angeles (see **California** [political map]).

The California Institute of Technology is in Pasadena. This college manages the Jet Propulsion Laboratory for the National Aeronautics and Space Administration (see **Jet Propulsion Laboratory**). The city's manufactured products include biomedical instruments. Pasadena is the home of Fuller Theological Seminary and Pacific Oaks College. The city's cultural facilities include the Norton Simon Museum of Art, the Pacific-Asia Museum, and the Pasadena Playhouse State Theatre of California. Mount Wilson Observatory is nearby.

The site of Pasadena was once part of the San Gabriel Mission, established by Spanish priests in 1771. In 1873, the land was purchased by the California Colony of Indiana, an organization founded by Thomas B. Elliott of Indianapolis. The original name, "Indiana Colony," was changed in 1875 to *Pasadena,* an Indian word meaning *valley between the hills.* Pasadena was incorporated in 1886 and chartered as a city in 1901. It has a council-manager government. Kenneth Reich

Pascal, *pas KAL* or *PAS kuhl,* a unit in the metric system, is used to measure pressure (force per unit of area). Its symbol is *Pa.* One pascal is the pressure of a force of 1 newton acting on an area of 1 square meter (see **Newton**). If a force of 30 newtons acts on an area of 5 square meters, the amount of pressure exerted is 6 pascals. Other metric units of pressure are the *kilopascal,* which equals 1,000 pascals, and the *bar,* which equals 100,000 pascals. In the inch-pound system, pressure is measured in pounds per square inch. One pascal equals about 0.000145 pound per square inch. The pascal was named for the French scientist Blaise Pascal. Hugh D. Young

Pascal, *pas KAL* or *PAS kuhl,* **Blaise,** *blehz* (1623-1662), was a French physicist, mathematician, and philosopher. He became known for his experiments with fluids in physics and for his work on probability theory in mathematics. In a work called *Provincial Letters,* Pascal helped create a modern French prose style.

Pascal's important work on the pressure of fluids produced the principle called *Pascal's law.* This principle, developed in the 1650's, states that fluid in vessels transmits pressure equally in all directions. It explains the operation of air compressors, vacuum pumps, and hydraulic elevators, jacks, and presses (see **Pascal's law**). Pascal's experiments helped prove that air has weight and that air pressure can produce a vacuum. At the time, many scientists doubted that a vacuum could exist.

In 1654, Pascal and French mathematician Pierre de Fermat corresponded about the outcomes of games of chance. Their correspondence laid the foundation for a theory of probability. That same year, Pascal published a work on conic sections and described a triangular arrangement of numbers in which each number in any row is the sum of the two numbers immediately above it. This arrangement, called *Pascal's triangle,* can be used to calculate probabilities. Pascal also invented a calculat-

ing machine that performed addition and subtraction.

Pascal was born on June 19, 1623, in Clermont-Ferrand. He showed early brilliance as a mathematician. Pascal became absorbed in a religious movement called Jansenism and in late 1654 entered a Jansenist convent at Port-Royal (see **Jansen, Cornelius**). The Jesuit religious order charged the Jansenists with heresy and condemned Jansenist leader Antoine Arnauld. In reply, Pascal published 18 immensely popular satirical pamphlets called the *Provincial Letters* in 1656 and 1657.

From 1658 until his death, Pascal worked on a defense of Christian faith. Fragments of this uncompleted work were discovered after his death and published as *Pensées*. This work expresses Pascal's belief that there are limits to the truths reason can know, and that faith from the heart in Christian revelation is the primary guide to truths. Ronald S. Calinger

See also **French literature** (Classical prose).

Pascal's law, *pas KALZ* or *PAS kulz,* also called *Pascal's principle,* describes the effect of applying pressure on a fluid in a closed container. It states that pressure applied to an enclosed fluid is transmitted with equal force throughout the container. The law explains why a thin-walled bottle filled with water and fitted with a cork may break when the cork is pushed down. Pascal's law was named for Blaise Pascal, a French scientist and mathematician of the 1600's. See also **Hydraulics; Pascal, Blaise.** Richard A. Martin

Paschal II, *PAS kuhl* (?-1118), was elected pope in 1099. Much of his troubled reign was occupied with the *investiture controversy.* The controversy was a quarrel over whether secular powers or the clergy had the right to *invest* (appoint) the clergy to religious offices.

In 1105, Paschal decided to support Henry V in Germany in a revolt against his father, Henry IV. In 1111, after his father's death, Henry V promised to support Paschal's plan for settling the investiture issue and, in return, the pope agreed to crown Henry as emperor. In Paschal's plan, the clergy would give up their secular powers and influence in the hope that secular leaders would leave investiture to church officials.

Paschal's plan collapsed in a storm of protest from the German clergy and nobility. Henry then kidnapped the pope and forced him to carry out the coronation. Henry also forced an agreement on investiture favorable to the imperial position. A few years later, Paschal renounced the agreement. Paschal was born in Italy. His given name was Rainerus. Thomas F. X. Noble

Pashtuns, *pash TOONZ,* are one of the largest ethnic groups in Afghanistan and Pakistan. They make up about half the population of Afghanistan and about one-fifth of the people of Pakistan. Most Pashtuns live near the border between Afghanistan and Pakistan.

Other names for the Pashtuns include *Pathans, Pakhtuns, Pukhtuns,* and *Pushtuns.* They speak Pashto, also called Pushtu or Pukhtu, a language related to Persian. Almost all Pashtuns are Muslims.

The Pashtuns consist of about 40 tribes divided into groups of related families. Democratic councils called *jirgah* govern tribal affairs. Although the tribes unite to fight invaders, they often feud with one another. Some of the feuds have raged for centuries.

Many Pashtuns work as farmers, raising wheat and other grains, fruits, nuts, and sugar cane. Others are nomads who breed horses and herd sheep, goats, cattle, and camels. Many farmers live in homes made of mud-brick. Most nomads live in tents made of goat hair. Some Pashtuns combine farming with nomadic herding.

Ancestors of the Pashtuns lived in what is now Afghanistan by about 4000 B.C. In the A.D. 1500's, some Pashtuns moved to present-day Pakistan. In the 1800's and early 1900's, Pashtun warriors became the dominant group among Afghans who fought and won a series of wars against the British. The United Kingdom was seeking control of Afghanistan's foreign policy as part of its competition with Russia for influence in the region.

In late 1979 and early 1980, the Soviet Union invaded Afghanistan. Pashtuns formed guerrilla bands to help repel the invasion. The Soviets withdrew from Afghanistan in 1988 and 1989. By the late 1990's, a Pashtun-dominated group known as the Taliban had taken control of most of Afghanistan. Afghan rebels, aided by the United States and its allies, forced the Taliban from power in 2001. Thomas E. Gouttierre

See also **Afghanistan** (People; History); **Pakistan** (People).

Pasqueflower, *PASK FLOW uhr,* is the name of three small plants with large flowers that open early in the spring. The name *pasqueflower* means *Easter flower.* Two species grow in Europe and one in North America. The North American species, called *pasqueflower* or *wild crocus,* is the state flower of South Dakota and the provincial flower of Manitoba. It grows throughout the Midwestern plains of North America. Its flowers range in color from lavender to deep purple and have yellow centers. The blossoms form on very short stems that grow longer as the seeds ripen. The fuzzy leaves have many leaflets that spread out like the fingers of a hand. See also **Flower** (picture: Flowers of prairies and dry plains). Anton A. Reznicek

Scientific classification. Pasqueflowers belong to the crowfoot family, Ranunculaceae. The North American pasqueflower is *Anemone nuttalliana;* the two European species are *A. patens* and *A. pulsatilla.*

Pass. See Mountain pass.

Passamaquoddy Bay, *PAS uh muh KWAHD ee,* is a part of the Bay of Fundy between Maine and New Brunswick, Canada. It cuts inland for about 15 miles (24 kilometers), and averages about 10 miles (16 kilometers) in width (see **Maine** [physical map]). The tides on the rocky Maine coast of Passamaquoddy sometimes rise as much as 27 feet (8 meters). The chief towns in Maine on Passamaquoddy Bay are Eastport and Lubec. The chief towns in New Brunswick are St. Andrews, St. George, and Blacks Harbour, which is the site of the world's largest sardine factory. Campobello and Deer islands lie in the bay, and Grand Manan Island is near the entrance to the bay. Important fisheries along the bay include herring, pollock, sardine, and lobster. T. W. Acheson

Passenger pigeon is an extinct bird that was once abundant in eastern North America. The last known passenger pigeon died in 1914 at the Cincinnati Zoological Gardens. Its body is now displayed at the National Museum of Natural History in Washington, D.C.

The male passenger pigeon grew about 16 $\frac{1}{2}$ inches (42 centimeters) long, with a long pointed tail; a short, black bill; and red eyes and feet. It had a gray-blue head and body. The feathers on the male's neck and throat

were wine-colored, with green and purple highlights. The female was similar but smaller with duller colors.

Scientists estimate that as many as 3 to 5 billion passenger pigeons lived across eastern North America in the year 1500. They nested from the Atlantic Coast as far west as Montana. The birds got the name *passenger pigeon* because they traveled often to new places to look for food. They flew rapidly, sometimes in huge flocks. One flock in 1810 was calculated to have over 2 million birds, enough to block out the sun.

Passenger pigeons nested chiefly in forests of oak and beech, where they ate acorns, beechnuts, berries, and grains. Their enormous breeding colonies averaged 30 square miles (78 square kilometers) in area. Females laid only one egg on each nesting attempt.

The great number of passenger pigeons began to decline in the 1850's. Many beech and oak forests were cut for use as fuel and lumber and to clear land for farms. As a result, much of the passenger pigeon's habitat was destroyed. Hunters also killed millions of nesting passenger pigeons for food, and some even dynamited the bird's colonies. People shipped barrels full of birds to the cities. These factors, combined with the pigeon's low reproductive rate and inability to nest in small colonies, doomed the bird to extinction. Edward H. Burtt, Jr.

Scientific classification. The passenger pigeon belongs to the pigeon family, Columbidae. It is *Ectopistes migratorius.*

See also **Audubon, John J.** (picture).

Passion-flower is a type of woody vine that has unusual blossoms. Roman Catholic priests of the late 1500's named it for the *Passion* (suffering and death) of Jesus Christ. They believed several parts of the flower, including the petals, rays, and sepals, symbolized features of the Passion. The flower's five petals and five petallike sepals represented the 10 apostles who remained faithful to Jesus throughout the Passion. The circle of hairlike rays above the petals suggested the crown of thorns Jesus wore on the day of his death. Passion-flowers are also called *granadillas* or *maypops.*

The priests who named the vine found it growing in what is now Latin America. Today, gardeners in many parts of the world raise passion-flowers for the blossoms. The flowers may be almost any color or combination of colors. Their diameter ranges from $\frac{1}{2}$ inch to 6 inches (13 to 150 millimeters).

Many species of passion-flowers bear a fruit called *passion fruit.* These round or oblong fruits range from yellow to purple in color and contain many edible seeds. Passion fruits taste slightly sour or very sweet, depending on the species. They are eaten whole and also are used to make juice, marmalade, ice cream, and other refreshments.

Most of the approximately 400 species of passion-flowers grow in warm regions of the world. The yellow fruit of the *purple granadilla* is the passion fruit most commonly used to make juice. Jaime E. Lazarte

Scientific classification. Passion-flowers belong to the passion-flower family, Passifloraceae, and they make up the genus *Passiflora.* The scientific name for the purple granadilla is *Passiflora edulis flavicarpa.*

Hugh Spencer, NAS

The passion-flower reminded early Roman Catholic missionaries in America of Christ's Passion, and they gave it this name.

Passion music is a vocal composition that dramatically tells the Gospel story of the suffering and Crucifixion of Jesus Christ. Passion music may involve a large chorus with instrumental accompaniment or just a few singers representing characters from the Gospels. Passion music is generally performed during Holy Week—that is, from Palm Sunday to Easter Sunday.

The oldest surviving Passion manuscripts date from the A.D. 800's, though Passion music may have existed earlier. Passions probably originated from the church custom of reciting the Gospel stories of Jesus's last days. During the 1600's and 1700's, the Passion developed into an elaborate dramatic musical form similar to the oratorio. One of the most famous works of this type is *The Passion According to St. Matthew* (1729) by the German composer Johann Sebastian Bach. It includes *recitatives* (speechlike sections), *arias* (songlike solos), choruses, and orchestral passages. Katherine K. Preston

Passion play is a dramatic performance that presents the death and resurrection of a god. The ancient Egyptians performed passion plays devoted to the god Osiris. The ancient Greeks presented similar plays dedicated to the god Dionysus. But the term *Passion Play*



Black Hills Passion Play

A passion play dramatizes the death and resurrection of a god. The Black Hills Passion Play performed in Spearfish, South Dakota, depicts the Crucifixion and Resurrection of Jesus Christ.

most often refers to plays that depict the suffering, Crucifixion, and Resurrection of Jesus Christ.

European townspeople and villagers of the late Middle Ages often staged Passion Plays. The plays enabled them to participate personally in the drama of Jesus's last days on earth.

Several towns in southern Germany, western Austria, and Switzerland continue the Passion Play tradition today. The most famous European Passion Play is presented by the town of Oberammergau in southern Germany. This play originated in 1634 as a show of thanks to God for sparing the town from a plague. The Oberammergau Passion Play normally is performed every 10 years. It lasts about 5 $\frac{1}{2}$ hours and includes over 800 performers (see **Oberammergau** [picture]). In the United States, Passion Plays are performed annually in several cities.

Albert Wertheim

Passover, also called *Pesah,* is a Jewish festival that celebrates the flight of the Israelites from Egyptian slavery, probably in the 1200's B.C. The story of Passover is told in the Bible in Chapter 12 of the Book of Exodus. Passover begins in March or April, on the 15th day of the Hebrew month of Nisan. Most Jews celebrate Passover for eight days, but Jews in Israel, and Reform Jews in other countries, celebrate it for seven days.

Jews celebrate Passover in their homes at a ceremonial feast called the Seder. At the Seder, the story of the flight of the Israelites is read from a book called the Haggadah. Foods symbolizing the flight from Egypt are placed on the table. The most important symbol is *unleavened* (unraised) bread called *matzo* (also spelled *matzah*). According to the Bible, when the Israelites fled, they did not have time to let their bread rise. They made flat, unleavened bread instead. Therefore, Jews eat matzahs instead of leavened bread during Passover.

The word *Passover* comes from the Biblical story of the 10th plague, which God brought on Egypt for keeping the Israelites in bondage. The story says God killed the first-born child in every Egyptian home but passed over the homes of the Israelites. The word *Passover* also refers to the passing over of the Israelites from slavery to freedom. Lawrence H. Schiffman

See also **Religion** (picture).

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Passport is a travel document that identifies the holder as a citizen of the country by which it is issued. A passport also requests other countries to give the holder safe passage and all lawful aid and protection. Sometimes a passport must have a *visa* (official endorsement) from the country a person desires to visit before entry into that country is permitted (see **Visa**).

The Department of State in Washington, D.C., issues passports in the United States. State Department officials in the following cities may also issue passports: Boston, Chicago, Detroit, Honolulu, Houston, Los Angeles, Miami, New Orleans, New York City, Philadelphia, San Francisco, Seattle, and Stamford, Connecticut. Applications may also be made before a clerk of a federal or state court authorized by law to naturalize aliens. Many U.S. diplomatic and consular offices can issue passports to U.S. citizens overseas. In Canada, passports are issued by the Department of External Affairs at Ottawa.

Many countries do not require citizens of certain other countries to have passports. United States citizens do not need passports to enter Bermuda, Canada, Mexico, and most of the West Indies. Robert J. Pranger

Pasta, *PAHS tuh,* is a food made chiefly from wheat products and water. It comes in more than 100 shapes and sizes. Some of the best known are macaroni, which consists of hollow tubes; spaghetti, which is made into long cords; and noodles, which are flat strips. Elbow macaroni has the shape of short, curved tubes, and shel macaroni resembles sea shells. Vermicelli is extremely thin spaghetti, and wide noodles are called lasagna noodles. Ravioli, another pasta product, consists of small, hollow squares stuffed with cheese or ground meat.

The word *pasta* is an Italian term meaning *dough.* The best pastas are made with medium-sized particles milled from *durum* (hard-grain) wheat. Manufacturers mix the particles with water and other ingredients, such as flour, to form a firm dough. The dough is either pressed through a machine or rolled out and cut into the proper shapes. The pasta is then dried with forced air until it is hard and brittle.

Pasta products are rich in *carbohydrates* (starches) and are a fairly good source of protein. *Enriched pasta* contains iron and the B vitamins thiamine, riboflavin, and niacin. Some pastas include such ingredients as milk or seasonings in addition to wheat products and water. Manufacturers add eggs to the pasta mixture to make egg noodles. *Green pasta* is made by mixing spinach with pasta dough.

Pasta dishes have been a specialty of Italian cooking since the 1200's, but they are now popular throughout the world. The bland flavor of pasta makes it a suitable ingredient to mix with cheese, meat, tomato sauce, and other foods. Pasta is boiled until it is soft but slightly chewy. It can then be combined with other foods in casseroles or salads. Margaret McWilliams

Pastel. See **Painting** (Pastel).

Pasternak, Boris (1890-1960), was a Russian poet an fiction writer. In the West, he is best known for his nov *Dr. Zhivago* (1957). Pasternak was awarded the Nobel Prize for literature in 1958. He accepted the award but then rejected it under pressure from the Soviet govern ment.

Authorities banned *Dr. Zhivago* in the Soviet Union. The novel was first published in Italy and then was trar lated into English and many other languages. Zhivago, Russian physician, experiences the suffering and disor der of his country's revolutionary period. He cannot ac cept Communist rule and tries to find happiness in lov and in the beauty of nature. The novel contains much a tobiographical material. Zhivago is also a poet and his beautiful poems are part of the book.

Boris Leonidovich Pasternak was born in Moscow. H showed great promise in musical composition and ph losophy before turning to poetry. His third book of poems, *My Sister Life* (1922), established his reputation as major Russian poet. For Russians, his greatness as a poet is paramount.

Pasternak's poems supported the Russian revolutions of 1905 and 1917, but he did not accept many of the strict doctrines of the Communist Party. During the 1930's and 1940's, the Soviet government prohibited the publication of most of Pasternak's writing. He earned a living by translating poems and plays by foreign writers, including Johann von Goethe and William Shakespeare. In 1957, the Soviet Writers Union expelled Pasternak, which meant that his works could not be published in the Soviet Union. The union reinstated him in 1987, almost 27 years after his death. In 1988, *Dr. Zhivago* was first published in the Soviet Union. Anna Lisa Crone

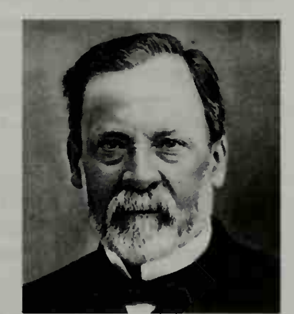
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Pasteur, *pas TUR,* **Louis** (1822-1895), of France, made major contributions to chemistry, medicine, and industry that have greatly benefited humanity. His discovery that diseases are spread by bacteria saved countless lives. Pasteur was a great theoretical scientist who applied his basic discoveries to important practical problems in both industry and medicine.

His work in chemistry brought him his first recognition. By the age of 26, Pasteur was famous for his work on the structure of crystals. But Pasteur soon started probing the mysteries of *bacteriology* (the study of bacteria). Others saw bacteria before Pasteur did. But he was the first to show that living things come only from living things. Before that, many scientists believed in *spontaneous generation,* a theory that life could come from things that are not alive, such as dirt. Pasteur also showed that although bacteria live almost everywhere, their spread can be controlled. See **Bacteria; Spontaneous generation.**

His work in industry. Pasteur is credited with saving the silk industry and wine industry in France. In the early 1860's, he noted that wine turns bitter because of *microbes* (germs) that enter the wine while it is being made. He showed that microbes can be killed by applying controlled heat. This use of heat as a means to kill germs became known as *pasteurization.* Pasteur also used this method to preserve milk and beer, and to preserve food. See **Pasteurization.**



Historical Pictures Service
Louis Pasteur

In 1865, Pasteur set out to help the silk industry. A disease called *pebrine* was killing great numbers of silkworms. He proved that a microbe that attacks silkworm eggs causes the disease. He showed that eliminating this germ in silkworm nurseries could wipe out the disease.

His work in medicine. Pasteur proved that many diseases are caused by germs that multiply in the body. He also proved that if microbes are weakened in a laboratory and then placed in an animal's body, the animal develops an *immunity* (resistance) to the microbe. He called this method of fighting off microbes *vaccination.* Pasteur proved the value of vaccination by vaccinating sheep against a disease called anthrax (see **Anthrax**). He also showed that vaccination could be used to prevent chicken cholera and other animal diseases.

Pasteur began in 1881 to study rabies, a deadly disease spread by the bite of rabies-infected animals. He spent endless hours in his laboratory seeking a vaccine to prevent rabies. One day in 1885, a rabid dog bit a boy named Joseph Meister. The boy's parents begged Pasteur to save their son. Pasteur hesitated to use his new vaccine on a human being, but he finally agreed. After several weeks of treatment, the vaccine proved successful. The boy did not get rabies. See **Rabies.**

His life. Pasteur was born on Dec. 27, 1822, in Dôle, France. His family moved to Arbois, where he received his early education. Pasteur was a slow but careful student who showed a talent for art. He later studied chemistry at the École Normale Supérieure in Paris.

In 1849, Pasteur became a chemistry professor in Strasbourg, France, where he began studying *fermentation,* a type of chemical breakdown of substances by microbes (see **Fermentation**). His work brought such improvements in brewing and winemaking that some say France was able to save enough money to pay its Franco-Prussian War debt.

Pasteur became director of scientific studies at the École Normale in 1857, but he left this post in 1867 to focus on his research. In 1868, a brain stroke partially paralyzed Pasteur. Despite his poor health, he continued his work. The Pasteur Institute in Paris, a world center for the study, prevention, and treatment of disease, was founded in 1888 in gratitude to him. He served as director of the institute until his death in 1895. Pasteur is buried in a tomb in the building. Kenneth R. Manning

See also **Bacteriology** (History); **Science** (picture).

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Pasteurization is a method of preserving food. It is most commonly used for milk, but it may also be used for beer, eggs, juice, and other food products. Pasteurization kills yeasts, molds, and *pathogenic* (disease causing) and most other bacteria. It also renders inactive certain enzymes (molecules that speed up reactions) that are naturally present in foods. It involves heating food at specific temperatures and for certain periods of time.

Almost all packaged milk sold in the world is pasteurized. Pasteurization is named after Louis Pasteur, a French scientist. In the mid-1800's, Pasteur discovered that gently heating wine would destroy most of the bacteria in it without altering the wine's flavor.

Phillip S. Tong

See also **Milk** (At a processing plant).

Pastorius, *pas TOH rih uhs,* **Francis Daniel** (1651-1719?), a German lawyer and scholar, founded Germantown, now part of Philadelphia. Pastorius became interested in the Society of Friends, or Quakers, at about the

time that William Penn founded the colony of Pennsylvania. Pastorius bought 15,000 acres (6,070 hectares) of land from Penn in 1683, and laid out the settlement of Germantown for German Quakers and Mennonites. Pastorius was born in Sommerhausen, Germany, near Würzburg. Oliver A. Rink

Pastry is a food baked from a stiff, short dough that is composed basically of flour, salt, shortening, and water. This dough is baked into plain, flaky, or puff pastries.

Different countries are noted for special kinds of pastry. French pastry is made from a puffy dough like that used for éclairs and cream puffs, or from a cake mixture cut into small shapes and decorated with frostings, glazed fruits, jellies, or nuts. Danish people make pastries of flaky yeast dough into which generous amounts of butter have been folded. The pastries may be filled with cream cheese, fruit, or nuts. Pie is the best-known pastry that is typically American. The flaky crust is created by folding layers of shortening between the flour and water. Kay Franzen Jamieson

Patagonia, *PAT uh GOH nee uh,* is a region in the southern part of South America. A large part of the region is desert. Indians lived in Patagonia long before white people arrived. The name *Patagonia* comes from a Spanish word that means *big feet.* The Indians were tall and wore large boots stuffed with grass.

In 1520, the Portuguese navigator Ferdinand Magellan became the first European to reach the region. In 1865, Welsh settlers came into Patagonia. The area was divided between Chile and Argentina in 1907 under the terms of an 1881 treaty.

Today, the term *Patagonia* usually refers to the Argentine section of the region. It includes the southern Argentine provinces of Río Negro, Chubut, and Santa Cruz, and the territory of Tierra del Fuego. Farmers raise sheep on large tracts of land in the region. Patagonia is an important source of energy for Argentina. Hydroelectric projects on the Limay River in northern Patagonia provide electricity. Oil fields in Patagonia yield much of Argentina's petroleum. The region also has coal and iron ore deposits. Jerry R. Williams

See also **Argentina** (Patagonia; terrain map).

Patchouli, *PACH u lee* or *puh CHOO lee,* is a strongly fragrant oil used in making perfumes. The oil comes from leaves of the patchouli plant, a member of the mint family. The leaves are dried in the sun. To increase the yield of oil, leaves are sometimes allowed to undergo *fermentation* (a chemical change that breaks down certain materials). Steam is then passed through the leaves to remove the oil. Farmers grow patchouli plants in China, India, Indonesia, the Philippines, and Singapore.

Patricia Ann Mullen

Patella. See Knee.

Patent is a document issued by a national government granting an inventor exclusive rights to an invention for a limited time. A patent gives an inventor, or any other owner of the patent, the right to prevent others from making, selling, importing, or using the invention in the country that granted the patent. In the United States, patents are administered by the United States Patent and Trademark Office.

To be eligible for a patent, an invention must be new, useful, original, and not easily discovered or created. United States patent laws consider inventions to include machines, methods, manufactured products, and compositions, plus new uses of inventions in each of these categories. Patents for these inventions and new uses are called *utility patents.* Utility patents may also be obtained for improvements of inventions and for most new varieties of plant life. Utility patents have also been granted for life forms created in a laboratory by genetic engineering. These life forms have included some types of corn and mice, and many kinds of microorganisms. Another type of patent, called a *plant patent,* is available for nonpollinating plants. A third kind of patent, known as a *design patent,* covers only an article's appearance.

An invention that would be obvious to anyone of ordinary skill in a given field cannot be patented. Such an invention might involve merely a substitution of materials, a change in the size of a machine, or a combination of known concepts without new and unexpected results.

How patents protect inventors

Patents give their owners a legal monopoly of an invention. In the United States, the monopoly granted by utility patents and plant patents gives the inventor a legal monopoly of an invention. This monopoly begins on the date the patent is issued and expires 20 years after the patent application was filed. The monopoly can be extended for up to 5 years if certain delays occur in the Patent and Trademark Office, in the courts, or in the U.S. Food and Drug Administration. Design patents are issued for 14 years. A patent can be renewed only by a special act of Congress.

Anyone who applies for a patent must pay a filing fee and, if the application is allowed, an issue fee. Utility patent holders who wish to keep their patents in force for the full 20-year period must make additional payments $3\frac{1}{2}$, $7\frac{1}{2}$, and $11\frac{1}{2}$ years after their patents were issued.

On average, the Patent and Trademark Office takes more than a year to process a patent application. To avoid delay in getting a newly invented product on the market, most manufacturers start to produce it soon after filing for a patent. The manufacturer marks the product "Patent Pending" or "Patent Applied For." This warning has no legal value, but it discourages imitation. A patented invention may be marked "Patented," together with the patent number. Copying a patented invention without permission is called *infringement.* The patent owner may sue for damages and a court order requiring the infringer to stop copying the invention.

An inventor may sell all or part of the rights given by a patent. The inventor may also license these rights to a manufacturer. Licensing gives the inventor a fee or *royalties* (payments based on sales), or both.

How to get a U.S. patent

Most governments grant a patent to the inventor who first applied for it. But in the United States, it is granted to the applicant who was the first inventor. For initial protection, an inventor should record the date the invention took shape in the mind and draw a sketch with a description of the idea. This document should be dated and signed by the inventor and two witnesses. It should be kept in a safe place.

By filing a *provisional patent application,* an inventor can establish a date of invention before building and

testing the invention. Unlike regular patent applications, provisional applications need not include *claims.* Claims define the scope of the invention and may take much time to prepare. The inventor obtains the benefit of the provisional application filing date only if he or she files a regular application within a year.

The preparation of a regular patent application that will fully protect the invention requires specialized legal knowledge. Most inventors use the services of a patent attorney or a patent agent who is registered to practice before the Patent and Trademark Office.

Before filing an application, the inventor or the inventor's attorney usually has a *search* conducted. The search involves a study of government patent files to determine whether a patent or other publication already describes the invention. United States law permits inventors to wait up to one year from the date of the publication, offer of sale, or sale of their inventions to apply for a patent.

A patent application consists of a *specification* (description), one or more drawings of the invention, and one or more claims. After the Patent and Trademark Office receives an application, an examiner conducts an official search of the patent files to learn whether the invention has already been patented or otherwise published. The application is then accepted or partially or completely rejected. If it is accepted, the inventor receives a *notice of allowance.* After payment of the issue fee, the specification and claims are printed, and the inventor receives a patent.

If the application is rejected, the inventor may amend the claims and argue for the patentability of the invention. If again rejected, an appeal may be made to the Patent and Trademark Office's Board of Patent Appeals and Interferences. If this fails, the decision can be challenged in court.

Patent laws of other countries

Patent laws vary from country to country. Most of the patent laws follow the principle that a patent is a bargain between the inventor and society. Inventors reveal their secrets in exchange for a monopoly for a limited amount of time. Society receives the benefit of the inventors' sharing their secrets. But the laws of various countries differ regarding the conditions under which applicants may make public their inventions before receiving a patent.

International patent agreements

A patent treaty now recognized by almost 100 nations, including Canada and the United States, went into effect in 1884. Each nation agrees to give citizens of the other countries the same rights to obtain a patent as it gives its own citizens. The treaty also benefits people who apply for a patent in their own country and then apply in any of the other countries within a year. Their later applications are treated as having been made on the same date as the one made in their own country.

In 1978, the Patent Cooperation Treaty (PCT) took effect. It provides for a search and a standard application form. Under this treaty, each nation retains its own patent laws, but the standard application replaces an individual nation's application. Each country then largely relies on the PCT search. David Pressman

See also **Intellectual property.**

Additional resources

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Patent leather. See Leather (Final processing).

Pater, *PAY tuhr,* **Walter Horatio** (1839-1894), an English essayist and critic, influenced the artistic taste of many English people in the late 1800's. Pater's most important and best-known work is the philosophic novel *Marius the Epicurean* (1885). It tells of a man in ancient Rome who admires beauty for its own sake. The novel was important in establishing the doctrines of *aestheticism,* the belief that beauty is the most meaningful thing in life. It also expressed the idea that an artist's sole responsibility is to strive for beauty. Pater's other notable work is a collection of essays on Renaissance artists, *Studies in the History of the Renaissance* (1873).

Pater was born on Aug. 4, 1839, in London. He graduated from Oxford University. Pater was elected a *fellow* (resident teacher) of Brasenose College at Oxford in 1864. The college was the center of his activities for the rest of his life. He began his career as a critic on art for two famous English magazines—the *Fortnightly Review* and *The Westminster Review.* K. K. Collins

Paterson, *PAT uhr suhn* (pop. 149,222), was one of the earliest industrial communities in the United States. It lies in northeastern New Jersey, on the Passaic River. For location, see **New Jersey** (political map). Paterson is the largest city in the Bergen-Passaic metropolitan area, which has a population of 1,373,167.

Paterson was founded in 1791. It grew from a small village near a massive waterfall on the Passaic River. Alexander Hamilton, the first U.S. Secretary of the Treasury, recognized the potential of the waterfall to provide power for manufacturing companies. He helped found the Society for Establishing Useful Manufactures (S.U.M.) to develop Paterson.

During the 1800's, Paterson became a center for textile production, a site for the construction of some of the nation's first steam locomotives, and a famous silk manufacturing center. For a brief time, the handgun developer Samuel Colt manufactured revolvers in Paterson.

In the early 1900's, Paterson was the site of a silk workers' strike and other labor disputes. The silk industry collapsed after the introduction of synthetic fibers. Many of Paterson's textile mills closed as firms moved out of state. During the 1930's and 1940's, the city was an important manufacturer of aircraft engines.

Today, service industries are central to Paterson's economy. But the city also manufactures cotton fabrics, fabricated metal products, printing machinery, and soap and other household cleaners. Many mills and other industrial sites are preserved in a historic district. Paterson has a mayor-council government. Paul G. E. Clemens

Paterson, *PAT uhr suhn,* **Katherine** (1932-), is an American author of children's books. She won the 1978 Newbery Medal for *Bridge to Terabithia* (1977). This novel tells about a friendship between a boy and girl from different cultural backgrounds and the imaginary kingdom they create. Paterson won the 1981 Newbery

Medal for *Jacob Have I Loved* (1980), a story about the rivalry between twin sisters. Paterson's other novels include *The Master Puppeteer* (1976), *Come Sing, Jimmy Jo* (1985), *Park's Quest* (1988), *Lyddie* (1991), and *Jip: His Story* (1996), which won the 1997 Scott O'Dell award. These works deal with moral issues and family life. Many of the main characters in these novels are young artists or strong thinkers.

Paterson was born in China, where her father was a missionary. She served as a missionary in Japan from 1957 to 1962. She received the 1988 Regina Medal for her contributions to children's literature.

Nancy Lyman Huse

Paterson, *PAT uhr suhn,* **William** (1745-1806), a lawyer and judge from New Jersey, was a signer of the Constitution of the United States. He helped write and presented the New Jersey Plan at the Constitutional Convention of 1787. This proposal gave each state an equal number of representatives in the national legislature. Although the plan was rejected, a compromise was later passed that gave states equal seats in the Senate. Paterson later helped win *ratification* (approval) of the Constitution by New Jersey.

Paterson was born in County Antrim, Ireland (now Northern Ireland). His family came to America when he was almost 2 years old, and William grew up in Princeton, New Jersey. Paterson graduated from the College of New Jersey in 1763 and earned a master's degree there in 1766. He began practicing law in 1769. From 1776 to 1783, Paterson was attorney general of New Jersey. Paterson served as a U.S. senator in 1789 and 1790. He helped draft the Judiciary Act of 1789, which set up the federal court system. Paterson served as governor of New Jersey from 1790 to 1793. He was appointed an associate justice of the Supreme Court of the United States in 1793. Richard D. Brown

Pathans. See **Pashtuns.**

Pathology, *puh THAHL uh jee,* is the study of disease, or any condition that limits the power, length, or enjoyment of life. *Comparative pathology* compares human diseases with those of animals. *Human pathology* is a branch of medicine. Pathologists use modern instruments and methods, such as electron microscopy, to recognize the changes caused by disease in the tissues and organs of the body. They try to explain why a diseased body acts differently from a normal body.

Pathologists use their knowledge of diseased tissues and body fluids to aid the physician. Pathological tests help physicians diagnose a disease and the extent of its attack. These tests may include examination of the blood, urine, and tissues. The use of laboratory tests to diagnose disease is called *clinical pathology.*

Pathologists also study diseased parts removed by surgery. They may examine corpses to learn the exact cause of death. This examination is called an *autopsy,* or *post-mortem examination.*

Special kinds of pathology study diseases of separate organ systems. For example, *neuropathology* concerns diseases of the nerves. Thomas P. Monath

See also **Gnotobiotics; Virchow, Rudolf; Morgagni, Giovanni B.**

Patmos, *PAT muhs* or *PAT mahs,* is a small volcanic island in the Aegean Sea, off Turkey's west coast. It is one of the Dodecanese Islands (see **Greece** [terrain map]). It was on Patmos that the author of the Book of Revelation saw his prophetic visions (see **Revelation, Book of**). The island covers 13 square miles (34 square kilometers) and has a population of 2,500. Almost all of the people depend for a living on tourism or the growing of citrus fruit and olives. Patmos was ruled by Turkey from 1537 to 1912, when Italy gained control. It was formally given to Italy by the Treaty of Lausanne, in 1923. It was given to Greece in 1947. John J. Baxevanis

Paton, *PAY tuhn,* **Alan** (1903-1988), was a South African author, social critic, and educator who wrote about the tragic consequences of rigid racial segregation. He became best known for his novel *Cry, the Beloved Country* (1948). The book tells of a struggle for human dignity amid racial conflicts in South Africa's gold mines, shantytowns, and law courts. *Too Late the Phalarope* (1953) is a novel about a sexual encounter between a white man and a black woman, then forbidden by South African law. *Tales from a Troubled Land* (1961) is a collection of short stories.

Paton, who was white, wrote several nonfiction books about South Africa's racial problems. He also wrote two autobiographies, *Towards the Mountain* (1980) and *Journey Continued* (1988).

Paton was born in Pietermaritzburg, South Africa. He became principal of the Diepkloof Reformatory for African boys, near Johannesburg, in 1935. He left in 1948 after instituting many reforms. Paton was a founder of what became the Liberal Party, an organization dedicated to attaining racial freedom through nonviolent means in South Africa. Michael Seidel

Patriarch, *PAY tree ahrk,* was the father or ruler of a family or tribe in ancient times. Abraham, Isaac, and Jacob were the patriarchs of the nation of Israel. Later, the president of the *Sanhedrin,* the highest governing council of the Jews, held the title of patriarch.

The early Christians used the title to honor the bishops of the largest and most important churches. The bishops of Rome, Alexandria, and Antioch were recognized as patriarchs in the early 300's. By the early 500's, the bishops of Jerusalem and Constantinople had come to be called patriarchs. In the Roman Catholic Church, the pope has the title *patriarch of the West.* Roman Catholic archbishops in some cities still hold the honorary title of patriarch. For example, cardinals hold the title in Alexandria and Antioch. The heads of some Eastern Orthodox Churches are called patriarchs. All Eastern Orthodox Churches regard the patriarch of Constantinople, called the *Ecumenical Patriarch,* as their spiritual leader. Ralph W. Quere

See also **Eastern Orthodox Churches; Mormons** (Church organization).

Patricians, *puh TRIHSH uhnz,* were aristocrats of the early Roman Republic (509-264 B.C.). The word *patrician* comes from the Latin word *pater* (father), which was used to describe members of the Roman Senate. Patricians belonged to wealthy families and were proud of their distinguished ancestors. They controlled the government, army, and state religion. They resisted attempts of the *plebeians* (commoners) to share their power. Until 445 B.C., a plebeian was not allowed to marry a patrician.

The two classes struggled for power for more than 200 years. During this time, the plebeians increased in

numbers and in wealth, and the number of patricians grew smaller. The patricians were forced to allow plebeians to hold more and higher positions. By 287 B.C., they could hold almost any civil or religious office, and could pass laws that affected everyone. The patricians and wealthy plebeians joined to form a new nobility, based on descent from high state officials.

Many patrician families died out between 133 B.C. and 27 B.C., the year the Roman Republic ended. Many emperors created new patricians, but the title was only an honor and carried no privileges. D. Brendan Nagle

See also **Plebeians**.

Patrick, Saint (about 389-461), is the patron saint of Ireland. Patrick was chiefly responsible for converting the Irish people to Christianity. He became known as the Apostle to the Irish. His name in Latin is Patricius.

His life. Patrick was born in Britain. His father was a wealthy alderman and a Christian. When Patrick was 16 years old, pirates captured him during a raid and sold him as a slave in Ireland. He served as a shepherd of an Irish chieftain in Ulster. During his captivity, Patrick dedicated himself to religion. He escaped after six years of slavery and returned to his home in Britain.

As a result of his experiences in Ireland, Patrick became driven by the idea of converting the Irish to Christianity. To prepare himself for that task, he studied in the monastery of Lérins, on an island off the southeast coast of France. Patrick also went to Auxerre, France, and studied religion under Saint Germanus, a French bishop. Partly because Patrick's earlier education was inadequate, his religious superiors were reluctant to let him return to Ireland as a missionary. But Palladius, the first Irish missionary bishop, died in 431. Pope Celestine I then sent Patrick to Ireland.



Detail of *The Baptism of the King of Cashel by St. Patrick* (about 1763), an oil painting on canvas by James Barry; Terenure College, Dublin

Saint Patrick, the patron saint of Ireland, was responsible for converting the Irish people to Christianity. This painting shows Patrick, *right,* converting an Irish chieftain.

Patrick began his work in northern and western Ireland, where no one had ever preached Christianity. He gained the trust and friendship of several tribal leaders and soon made many converts. Patrick is said to have founded more than 300 churches and baptized more than 120,000 people.

Patrick brought clergymen from England and France for his new churches. He succeeded in his mission in Ireland, even though many British clergymen opposed him and the way he organized his churches. Patrick preached in Ireland for the rest of his life.

His writings serve as the most important sources of information about Patrick's life and work. During his later years, he wrote *Confession,* an account of his spiritual development. Patrick wrote this book to justify his mission to Ireland. In the book, Patrick expressed his humility and thankfulness that God called him to serve the Irish. Patrick also wrote *Letter to Coroticus.* In this letter, he criticized a raid on Ireland conducted by Coroticus, a British chieftain. Several of Patrick's converts were killed during the raid. The letter also shows Patrick's resentment of the scornful attitude of British clergymen and nobility toward the Irish.

Legends about Patrick. Many stories about Patrick are based only on legend. One of the best-known tales tells how he charmed the snakes of Ireland into the sea so they were drowned. According to another legend, Patrick used a three-leaf shamrock to illustrate the idea of the Trinity. Many people believe the shamrock came to be the traditional symbol of Ireland as a result of this legend. Today, Irish Catholics throughout the world celebrate Saint Patrick's Day on his feast day, March 17 (see **Saint Patrick's Day**). William J. Courtenay

See also **Ireland** (Saint Patrick).

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Patrick Air Force Base, Florida, is the home of the United States Air Force's Eastern Space and Missile Center. The base covers about 2,300 acres (930 hectares) south of Cape Canaveral. The Eastern Space and Missile Center manages the Eastern Test Range, which extends southeast across the Atlantic Ocean into the Indian Ocean. There, the Eastern Test Range joins with the Western Test Range. The two ranges use electronic sensors on islands and ships to track rocket launches and orbiting vehicles.

Patrick Air Force Base was established in 1940 as the Banana River Naval Air Station. During World War II (1939-1945), it served as a base for antisubmarine patrol planes. It was transferred to the Air Force in 1948 and renamed after Major General Mason M. Patrick, who was chief of the Army Air Corps in the 1920's.

Wayne Thompson

Patriotism is the love of one's country. It includes attachment to the country's land and people, admiration

for its customs and traditions, pride in its history, and devotion to its welfare. The term suggests a feeling of oneness and membership in the country.

Patriotism has existed in all ages and among most peoples. Evidence of patriotism can be found in the art, literature, and music of many countries. Many artistic masterpieces glorify a country's leaders, historical events, and scenery. Numerous literary works praise love of country and willingness to suffer even death in defense of a country's freedom and good name. Patriotic songs and slogans have helped unite citizens in support of their country during periods of war, revolution, or economic development.

Schools help develop patriotism by creating an appreciation for common memories, hopes, and traditions. Through the study of history, for example, many students learn to love their country and admire its heroes. Patriotic organizations maintain and promote such symbols of patriotism as the national anthem, national flag, and national shrines and monuments. Leading patriotic organizations in the United States include the American Legion and the Veterans of Foreign Wars. *World Book* has separate articles on these and many other patriotic organizations. See **Veterans' organizations** with its list of related articles.

Most people agree that patriotism involves serving one's country, but many disagree on how they can best perform such service. Some say that the national government speaks for the country and that citizens should therefore actively support all government policies and actions. Others argue that a true patriot will speak out if convinced that the country is following an unjust or unwise course of action.

Foundations of patriotism. The word *patriotism* comes from a Greek word that means *fatherland.* Throughout most of history, love of fatherland or homeland was simply a love for the physical features of the land, including mountains, plains, and rivers. But the idea of patriotism has changed since the 1700's, in part because of the rise of such political ideals as democracy and Communism. For example, many people believe strongly in the democratic ideal, according to which people have a right to govern themselves. These people may have strong patriotic feelings because they live in a democratic country and support its institutions.

Patriotism has also changed since the 1700's because of the rise of *nationalism.* Nationalism is a people's sense of belonging together as a nation. Here, the word *nation* refers to a group of people who share a common culture, history, or language and have a feeling of unity. But the boundaries of a nation do not necessarily match the boundaries of a country or state. A *country* is an area of land whose people have an independent government. The people of a nation may be ruled by the governments of more than one country, and a single country may contain people of more than one nation.

In some cases, strong feelings of nationalism contribute to patriotism. If people feel that their country represents them as a nation and reinforces their common culture, their nationalistic feelings often include patriotism. This is especially true in the case of a *nation-state,* which exists when a nation and a state or country have the same boundaries.

However, nationalism may conflict with patriotism when the people of a nation do not identify with the country that rules part or all of their homeland. For example, many of the African countries that gained independence in the mid-1900's were established with the same boundaries as earlier European colonies. Many of these boundaries cut across the homelands of African ethnic groups. As a result, people of these groups may feel closer ties to neighbors in another country than to other groups in their own country.

Abuses of patriotism. Patriotism, like other emotional attitudes, sometimes becomes exaggerated or distorted. People who are excessively attached to a certain country are sometimes called *superpatriots.* An unreasoning enthusiasm for the military superiority and glory of one's country is called *chauvinism* or *jingoism* (see **Jingoism**).

Exaggerated or distorted forms of patriotism have existed in almost all countries. In the late 1800's, the French and British believed they had a moral responsibility to establish colonies in Asia and Africa, and thus bring the benefits of their culture to their "inferior brothers." In the 1900's, the Germans under Adolf Hitler and the Italians under Benito Mussolini became convinced their countries had a patriotic mission to extend their territorial boundaries.

Demands for public demonstration of loyalty to a country are often heard in times of crisis. During World War I (1914-1918), for example, the loyalty of Americans of German ancestry was questioned in the United States. During World War II (1939-1945), thousands of patriotic Japanese-Americans were placed in detention camps because of unreasonable fears that they might be loyal to Japan rather than to the United States.

The concept of patriotism has often been distorted by a government or a person for selfish gain. After World War II, for example, the government of the Soviet Union denied Soviet citizens a right to leave the country, on the grounds that a patriotic person would not wish to do so. In the United States during the 1950's, U.S. Senator Joseph McCarthy charged that Communists had infiltrated the U.S. government. In his charges, he strongly questioned the patriotism of numerous government officials and accused them of treason. Many historians believe McCarthy used the issue of patriotism to help boost his political career. Karen A. Cerulo

See also **Nationalism.**

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Patronage, *PAY truh nihj,* in politics is the power to name appointees to government jobs. In the United States, the president and various state and local officials can appoint people to certain positions. Appointments are usually suggested by national and state politicians. They often use patronage to reward those who worked for them in political campaigns. Such a use of patronage is called the *spoils system* (see **Spoils system**).

Peter Woll

See also **City government** (Patronage); **Political party** (Party organization in the United States); **President of the United States** (Party head).

Patrons of Husbandry. See Grange, National.

Patroon system, *puh TROON,* was a plan set up by the Dutch West India Company in 1629. It was used to colonize New Netherland, in what are now the states of New York, New Jersey, Delaware, and Connecticut. Any member of the company who paid to bring over 50 settlers within four years could have a large tract of land. The settlers had to be at least 15 years old. The *patroon* (owner of the land) became a kind of feudal lord who controlled all aspects of the settlers' lives, including their right to move, go into business, or even marry.

Five patroonships were granted. But only Rensselaerswyck, the Van Rensselaer manor, lasted into the 1700's. The system failed because few people were willing to give up their personal freedom permanently. Other land policies of the company contributed to the failure of the patroon system. For example, the company offered free land in New Netherland to settlers who paid their own passage to America. Later, the company even paid the passage to attract settlers. Joan R. Gundersen

See also Antirenters; New York (Exploration).

Pattern. See Cast and casting; Design; Sewing.

Patton, George Smith, Jr. (1885-1945), was one of the most colorful American generals of World War II. His dramatic manner, outspoken comments on military and political affairs, and reckless behavior won him both applause and criticism. His toughness and rough speech earned him the nickname "Old Blood and Guts."

African invasion. In November 1942, Patton led the Western Task Force ashore in Morocco in the Allied invasion of North Africa. In March 1943, he took command of the Second U.S. Army Corps and won one of the first major U.S. victories of the war at El Guettar. Before the Tunisian campaign ended, Patton took command of the Seventh Army for the invasion of Sicily in July 1943. In 39 days, his army and the British Eighth Army captured the island. But an event soon after that nearly wrecked Patton's career. While inspecting army hospitals, he slapped two soldiers who were suffering from battle fatigue. One of the soldiers also had malaria. Patton explained that he thought the soldiers were only pretending. General Dwight D. Eisenhower forced Patton to apologize, and Congress temporarily held up his permanent promotion to major general. Patton's usefulness was seriously harmed for several months.


U.S. Army

George S. Patton, Jr.

Victory in France. In January 1944, Patton became commander of the Third Army for the French campaign. When the First Army broke through at St. Lô, Patton's forces poured through in the first of an amazing series of advances. They went so far ahead of their supplies that they had to be provisioned by plane. His forces crossed France, reaching Metz by autumn, and fought in the Battle of the Bulge near Bastogne, Belgium, in December 1944.

As Germany collapsed, the Third Army drove across southwestern Germany into Czechoslovakia and Austria. When the Germans surrendered, Patton's army held a large part of what became the American occupation zone. Patton became a full general. After May 1945, he took command of the occupation troops in the American zone. But, in talking with reporters, he compared the Nazis to the losers in an American political election. These comments got him in trouble again with the press and his superior officers. Eisenhower transferred him to the command of the Fifteenth Army, a headquarters set up to interview captured German generals and prepare materials for the official history of the war. In December 1945, Patton died of injuries from a car accident. He was buried in a Third Army cemetery in Luxembourg.

Early life. Patton was born on Nov. 11, 1885, in San Gabriel, California. He was graduated from the U.S. Military Academy in 1909. An excellent athlete, he placed fifth in the 1912 Olympic pentathlon. Patton entered the cavalry after graduation, and served in the 1916 Mexican expedition. In World War I, he commanded a tank brigade in France. James L. Stokesbury

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Paul I (1901-1964) was king of Greece from 1947 to 1964. He succeeded his brother, George II, as king during a civil war between Greek Communists and people who supported the monarchy. With his wife, Queen Frederika, Paul tried to make the Greek monarchy a protector of democracy and a supporter of all classes of Greek society. From 1917 to 1920, Paul lived in exile with his father, King Constantine I. From 1923 to 1935 and from 1941 to 1946, he lived in exile again, this time with George II. Paul was born in Athens, and was trained as a naval officer. John A. Koumoulides

See also Constantine II; George II (of Greece).

Paul III (1468-1549) was elected pope in 1534 and reigned during the transition in Rome from the Renaissance to the church renewal movement called the Counter Reformation. While in many respects a Renaissance prince, Paul devoted serious attention to religious matters and helped further church reform. He named prominent theologians and churchmen to the college of cardinals, and he encouraged the development of new religious orders, notably the Society of Jesus, commonly called the Jesuits. In 1545, he convened the Council of Trent, which played a major role in the Counter Reformation (see Trent, Council of).

Paul was born in Canino, Italy, near Viterbo. His given and family name was Alessandro Farnese. Like many other Renaissance popes, he promoted the interests of his powerful family. He was an important patron of the arts, commissioning the completion of the elegant Farnese Palace and Michelangelo's painting *The Last Judgment* in the Sistine Chapel. Charles L. Stinger

See also Pope (Renaissance and Reformation).

Paul IV (1476-1559) was elected pope in 1555. He reflected the most repressive tendencies of the church renewal movement called the Counter Reformation. Paul was harsh and intolerant and rejected any reconciliation with Protestantism during the Reformation. He de-

nounced the religious settlement of the Peace of Augsburg (1555) for recognizing Lutheranism in Germany. Paul viewed any deviation from rigid orthodoxy with suspicion. He greatly extended the activities of the Inquisition, and the first Index of Forbidden Books was given official status in 1557. See **Ghetto; Inquisition; Index of Forbidden Books.**

Paul was born near Benevento, Italy. His given and family name was Gian Pietro Carafa. He was personally ascetic and in 1524 he helped found the Theatines, a monastic order dedicated to a life of poverty and to church reform. Paul became a cardinal in 1536 and led the church reform party in Rome. Beginning in 1550, he headed the Roman Inquisition, gaining a reputation for unyielding severity. Charles L. Stinger

Paul VI (1897-1978) was elected pope of the Roman Catholic Church in 1963. He immediately pledged to continue Vatican Council II, called by John XXIII, the previous pope. Paul presided over the council, which ended in 1965 and which brought widespread reforms to the church. See **Vatican Council II.**

In 1964, Paul traveled to Jerusalem, where he met with the ecumenical patriarch of Constantinople, Athenagoras I. The Eastern Orthodox Churches give the highest honor to this official. At the Vatican Council, the two leaders issued a joint statement removing the excommunications issued by the Eastern and Western churches against each other in 1054. In 1965, Paul flew to New York City—the first papal visit to the United States—to plead to the United Nations for world peace.

Paul wrote several *encyclicals* (pastoral letters). They dealt mainly with dialogue among Catholics, non-Catholics, and non-Christians and with the need for social justice within nations and between richer and poorer nations. But Paul is perhaps best remembered for *Humanae Vitae* (*On Human Life*), issued in 1968. This encyclical upheld the church's traditional prohibition against artificial means of birth control.

During his reign, Paul was often criticized as an extreme conservative. Today, many church historians consider him far more moderate than his critics recognized. After Vatican Council II, Paul had to skillfully steer the church on a middle course between liberals and conservatives. The liberals wanted to reform the church further than Paul thought was possible, while the conservatives rejected the council's reforms altogether.

Paul was born in Concesio, Italy, near Brescia. His given and family name was Giovanni Battista Montini. He was ordained a priest in 1920. After graduate studies in Rome, Paul served in the papal secretariat of state, with only a brief interruption, from 1922 to 1954. In 1954, he was appointed archbishop of Milan. John XXIII made him a cardinal in 1958. Gerald P. Fogarty

See also **Pope** (picture: Paul VI).

Paul, Alice (1885-1977), became one of the first American leaders of the movement for equal rights for women. She was sometimes called the mother of the Equal Rights Amendment to the U.S. Constitution.

Paul was born in Moorestown, N.J. She received a Ph.D. degree in social work from the University of Pennsylvania in 1912 and earned three law degrees during the 1920's. From 1907 to 1910, Paul worked with British women in their struggle to obtain the right to vote. After returning to the United States, she organized protest marches calling for the government to grant voting rights to women. The 19th Amendment, which gave women the right to vote, became part of the Constitution in 1920.


Brown Brothers

Alice Paul

In 1913, Paul formed the National Woman's Party, which supported equal rights for women. She submitted the first version of the Equal Rights Amendment to Congress in 1923. Paul worked with international women's organizations in the 1930's and founded the World Woman's Party in 1938. June Sochen

Paul, Saint, was one of the most important leaders of early Christianity. He became famous as a missionary and a founder of congregations throughout Asia Minor and southeastern Europe. His letters, called *epistles,* to his followers form a significant part of the New Testament. Because of his importance, Paul is sometimes referred to as an "apostle," though he was not one of the 12 apostles of Jesus Christ.

Early life. Paul, a Jew by birth, was born a few years after the birth of Jesus. Paul was born in Tarsus, a city in Cilicia (now part of Turkey). His original name was Saul. He grew up exposed to both his family's Jewish religious heritage and the non-Jewish culture around him. As a youth, Paul went to Jerusalem and studied under the famous rabbi Gamaliel.

In Jerusalem, Paul met Jews who had become Christians. They believed that Jesus, who recently had been crucified, was the *Messiah,* the promised savior of the Jews. Paul began to persecute these Jews because he found their beliefs and behavior contrary to the traditions of his people. But one day, while traveling to Damascus, Paul encountered the risen Christ. This experience impressed Paul so greatly that he soon became a Christian.

Missionary career. Paul's work in bringing Christianity to *gentiles* (non-Jews) shows his tremendous energy and dedication. He is often called the "Apostle to the Gentiles." Immediately after Paul's conversion, he went to an area of Arabia that is now in Jordan, and then to Syria and Cilicia. Historians know little about Paul's life as a missionary during the next 15 years.

The most productive period of Paul's career began shortly before A.D. 50. The Acts, a book of the New Testament, describes Paul's three journeys as a missionary during this period. On his first journey, Paul sailed to the island of Cyprus with two of his followers, Barnabas and Mark. He and Barnabas then crossed to the southern coast of Asia Minor. The story of this journey describes Paul's technique as a missionary. He moved quickly from place to place, preaching first in synagogues and then to gentiles. He gave bold, controversial speeches that angered many people. As a result, Paul was frequently mistreated and occasionally imprisoned.

Two other followers, Silas and Timothy, accompanied Paul on his second missionary journey. On this trip, Paul traveled to northwest Asia Minor. He then crossed to Macedonia, thus bringing Christianity to Europe. Later



Saint Paul made three important missionary journeys during the late A.D. 40's and 50's. He preached in Asia Minor and brought Christianity to Macedonia and Greece. On a fourth trip, he was sent as a prisoner to be tried in Rome.

WORLD BOOK map

on this journey, Paul visited such Greek cities as Thessaloniki and Corinth. Paul's third missionary journey covered much of the same territory as his second trip.

Later years. After Paul returned to Jerusalem, he was arrested because of opposition from hostile Jews. He spent two years in prison and then demanded his right as a Roman citizen to have a trial in the emperor's court. Paul was sent to Rome, where he remained a prisoner for two more years. He apparently died in Rome sometime after A.D. 60. His feast day is June 29.

Paul's letters and ideas. The letters written by Paul helped him keep in touch with his followers. They date from a period between A.D. 50 and the early 60's and are the earliest books of the New Testament. Paul wrote Romans, First and Second Corinthians, Galatians, Philippians, First and Second Thessalonians, and Philemon. He probably also wrote Colossians and may have written Ephesians, First and Second Timothy, and Titus. The Epistle to the Hebrews, once credited to Paul, is now considered the work of another writer.

Paul viewed Christianity primarily in relation to Judaism. He felt that the history of the Jews and the writings of the Old Testament had prepared humanity for Christianity. Nevertheless, Paul regarded the Christian faith—or "life in Christ," as he called it—as something new. In Judaism, God and human beings were related chiefly through the *Torah,* the first five books of the Old Testament. The Torah expressed God's will and informed people of their responsibilities to Him.

Paul believed the death and Resurrection of Jesus opened a new kind of relationship between God and human beings. He was certain that gentiles, who did not know or understand the Torah, could benefit from this new relationship, which he called *justification.* Justification resulted not from something that human beings did, such as obey the Torah, but from something that God had done. In Jesus, God had given humanity a gift. Paul felt that this gift put God and people into their proper relationship, which human effort alone never could have done. To Paul, justification was central to Christianity.

By means of his letters, Paul encouraged early Christians in times of discouragement and persecution. He reminded his followers of their responsibilities to one another and thus provided many basic ideas of Christianity. Christians recognized Paul's importance by preserving his letters and making them a central part of the New Testament. David B. Burrell

Related articles in World Book include:

Colossians, Epistle to the
Corinthians, Epistles to the
Ephesians, Epistle to the
Galatians, Epistle to the
New Testament (Paul's missionary journeys)
Philemon, Epistle to
Philippians, Epistle to the
Romans, Epistle to the
Thessalonians, Epistles to the
Timothy
Titus

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Paul Bunyan. See Bunyan, Paul.
Paul Revere's ride. See Revere, Paul; Revolutionary War in America (Lexington and Concord).

Pauli, *PAW lee,* **Wolfgang** (1900-1958), an Austrian theoretical physicist, won the 1945 Nobel Prize in physics for his proposal in 1925 of a rule explaining the behavior of electrons in atoms. Such electrons orbit the nucleus of the atom. The rule, now called the *Pauli exclusion principle,* holds that no two electrons in an atom can have the same *quantum numbers.* An electron in an atom has four such numbers. They define the energy of the electron in terms of the distance of its orbit from the nucleus, the orbit's shape, the orientation of the axis of the orbit, and the electron's spin on its own axis.

Pauli's principle was a key new idea. In 1913, Danish physicist Niels Bohr had published a theory describing how the single electron of the hydrogen atom moves around the nucleus. Pauli's discovery enabled scientists to picture the atomic structure and the behavior of the electrons of every known chemical element. Because the behavior of an atom's electrons determines how it will take part in chemical reactions, the principle also explained the chemical characteristics of the elements.

Pauli also explained the loss of energy and *angular momentum* (a measurement of spin) in certain atom-smashing experiments. In 1930, he proposed the existence of a subatomic particle, now called a *neutrino,* that has the "missing" energy and momentum. See **Neutrino.**

Pauli was born in Vienna, Austria. In 1928, he became professor of theoretical physics at the Federal Institute of Technology in Zurich, Switzerland. Richard L. Hilt

Pauline Letters. See Bible (Books of the New Testament); Paul, Saint.

Pauling, Linus Carl (1901-1994), an American chemist, won two Nobel Prizes. He received the 1954 Nobel Prize in chemistry and the 1962 Nobel Peace Prize.

Pauling won the chemistry prize for his research on the nature of chemical bonds. He showed that a knowledge of the way atoms are linked helps explain the structure of complex molecules. Pauling began his research by studying the structure of crystals. He analyzed the way atoms in a crystal *diffract* (spread out) X rays as the rays pass through the crystal. Pauling combined his findings with the theories of *quantum mechanics* about the arrangement of electrons within an atom and the ways in which atoms share and exchange electrons (see Quantum mechanics). In this way, he calculated the energies that bind atoms, the distances between the atoms, and the angles at which the bonds form.

Much of Pauling's research involved the study of *amino acids,* the organic compounds that make up proteins. His work contributed greatly to an understanding of the complex molecular structure of proteins. It also led to new knowledge about *sickle cell anemia,* a disease of the red blood cells. Pauling later attracted attention for his experiments on the use of vitamin C in treating cancer and the common cold.

Pauling won the Nobel Peace Prize for his efforts to ban nuclear weapons, especially his campaign against nuclear weapons testing. In 1958, he submitted a petition to the United Nations (UN) that stated in part: "Each added amount of radiation causes damage to the health of human beings all over the world." More than 11,000 scientists from 49 countries signed the petition. It helped lead to the signing of a treaty in 1963 that outlawed nuclear tests in the atmosphere, in outer space, and underwater—but not underground. Most UN members signed the treaty.

Pauling was born in Portland, Oregon. He received a Ph.D. degree from the California Institute of Technology in 1925. Edward E. Daub

Paulists are members of the first Roman Catholic order of priests to be founded in America. Isaac Thomas Hecker, an American priest, founded the order in New York City in 1858. Its full name is the Society of Missionary Priests of St. Paul the Apostle. Hecker founded the Paulists as a community of priests dedicated to Americanizing immigrant Roman Catholics and carrying Catholicism to non-Catholic Americans. Today there are only about 250 Paulists in the United States, Canada, and Rome. Despite their small numbers, the Paulists have been influential, especially through their effective use of print media, radio, and television. David G. Schultenover

Pavarotti, *pah vah RAHT tee,* **Luciano,** *loo chee AHN oh* (1935-), an Italian lyric tenor, was one of the most popular opera stars of the 1900's. He won fame for the warmth and flexibility of his voice, the security of his high notes, and the intense feeling in his singing.

Pavarotti has concentrated mostly on Italian operas and songs. He won fame for his performances in such roles as Rodolfo in *La Bohème,* Edgardo in *Lucia di Lammermoor,* and the Duke of Mantua in *Rigoletto.* In the late 1970's, he began to perform more dramatic roles, including Mario in *Tosca* and Manrico in *Il Trovatore.* In the 1980's and 1990's, his frequent appearances on TV and in operas and concerts on videocassettes increased his fame. Also during the 1990's, Pavarotti and tenors



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Luciano Pavarotti, an Italian lyric tenor, is one of the world's most popular concert and opera singers.

Jose Carreras and Placido Domingo gave a number of enormously popular concerts throughout the world, called "The Three Tenors."

Luciano Pavarotti was born in Modena, Italy. He made his professional debut in Reggio nell' Emilia, Italy, in 1961 as Rodolfo, and his Metropolitan Opera debut in 1968 in the same role. John H. Baron

See also Opera (picture: *La Bohème*).

Pavlov, *PAV lahv,* **Ivan Petrovich,** *ih VAHN peh TRAW vihch* (1849-1936), a Russian physiologist, won the 1904 Nobel Prize for physiology or medicine for his research on digestion. He showed how the *vagus nerve* controls the flow of digestive juices of the stomach and pancreas. For the next 30 years, Pavlov studied brain functions. He found that, by repeated association, an artificial stimulus (such as a bell) could be substituted for a natural stimulus (food) to cause a physiological reaction (salivation). He called this a *conditioned reflex.* Pavlov believed that all acquired habits, and even higher mental activity, depend on chains of conditioned reflexes.

Pavlov was born in Ryazan, Russia. He was educated in Russia and Germany. Audrey B. Davis

See also Behavior (Behaviorism); Nobel Prizes (picture: Ivan Petrovich Pavlov); Reflex action.

Pavlova, *pahv LOH vuh,* **Anna,** *AHN nah* (1881-1931), a Russian ballerina, became the most famous dancer of her generation. Anna Pavlova was a small, delicate woman whose style of dancing was lovely and graceful. She was best known for "The Dying Swan," a three-minute solo she performed in many parts of the world.

Anna Pavlova was born in St. Petersburg. She graduated from the Imperial Ballet School in 1899 and joined the Imperial Ballet Company. In 1906, she became its prima ballerina. She left Russia permanently in 1914 and settled in London. She later formed her own company and took it on world tours. Katy Matheson

See also Ballet (picture).

Pawnbroker is a person who lends small sums of money on articles of clothing, watches, jewelry, and

other belongings that are left with the pawnbroker as security. The articles that are left are *pawned.* The pawnbroker has the right to sell these articles if the loan is not repaid with interest and charges within a certain time after the debt becomes due.

The pawnbroker usually limits the loan to a small fraction of the value of the article, which provides security for the loan. For this reason, pawnshop customers do not usually regard the transaction as a sale of their goods. Customers pay back the loan with high interest to redeem their property. The pawnbroker is sometimes called the poor person's banker. He or she makes it possible for a person without employment or in financial distress to obtain credit quickly, even in a strange city. Pawnshops are disappearing from many areas due to the widespread availability of credit cards, which provide easy access to small loans at lower interest rates.

Pawnbroking dates back to the time when there were no banks. Many American cities had pawnshops as early as 1800. But the business was not generally recognized throughout the nation by law until the late 1800's. Then laws were passed by states and cities to curb abuses, such as unfair charges. In most cases, state laws restrict the maximum interest rates pawnbrokers may charge.

In general, regulations require the pawnbroker to keep a record book. It contains a description of every article received. This book must be submitted upon request to the police or other authorities who may be looking for stolen goods. The pawnbroker is not allowed to receive goods from anyone under the influence of liquor, or from anyone under a specified age.

Three golden balls, an old trade sign of the pawnbroker, usually hang outside the pawnshop. They originated with the moneylenders of Lombardy in Italy, who were important bankers in medieval England. The three golden balls were also the coat of arms of the Medici family, the richest merchants and moneylenders of Florence. Carol S. Greenwald



Bettmann Archive

Anna Pavlova, Russian ballerina, performed with a lightness and grace that few ballet dancers have ever attained.

Pawnee Indians, *paw NEE,* are a tribe that lives largely in the Pawnee, Okla., area. Many young members of the tribe have government jobs.

The Pawnee once lived in what is now Nebraska. Most of the year they lived in villages and raised corn, beans, and squash. The villages consisted of 10 to 12 large, round, earth-covered houses. The Pawnee left their villages once or twice a year to hunt buffalo on the plains. During the hunting season, they lived in tepees made of buffalo skins. Pawnee men shaved their heads except for a small scalp lock. They stiffened the scalp lock with grease and paint so that it stood up like a horn.

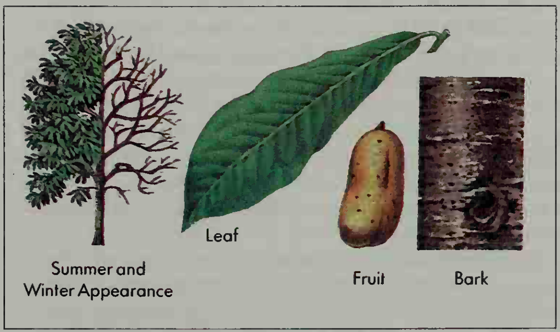
Religion played an important role in Pawnee life. The Pawnee regarded corn as a sacred gift, and many of their religious ceremonies centered around corn. Other ceremonies involved buffalo hunting and war. One Pawnee ceremony involved human sacrifice. But in 1838, opposition from within the tribe ended the practice.

A treaty signed in 1857 between the Pawnee and the United States restricted the tribe to a reservation along the Loup River in Nebraska. In 1875, because of pressure from white settlers and attacks by other tribes, the Pawnee moved to the Indian Territory (now Oklahoma).

Today, the Pawnee are governed by two groups. The Pawnee Tribal Business Council handles the tribe's business and financial matters. Any council action regarding tribal membership or treaties is subject to approval by the Nasharo (Chiefs) Council. Jen Shunatona Cale

Pawpaw is a small tree or shrub native to North America. The tree produces a fruit, also called *pawpaw,* that looks somewhat like a thick, short banana. The plant is found in the southern United States, and as far north as Kansas, Michigan, and New Jersey. Its leaves spread out in umbrellalike whorls. When the leaves are bruised they give off a disagreeable odor.

The pawpaw grows from 10 to 40 feet (3 to 12 meters) high and bears fruit 2 to 6 inches (5 to 15 centimeters) long. The fruit has yellowish-green or greenish-brown skin and a yellowish or greenish-white flesh. Those with yellowish flesh have a pleasant taste and are often eaten fresh. Those with greenish-white flesh generally are not eaten. The wood of the tree is too soft and coarse to be valuable.



WORLD BOOK illustrations by Chris Skilton

The pawpaw tree is native to North America.

Another tree, called *pawpaw, papaw,* or *papaya,* is grown in the tropics for its edible fruit. In Florida, it is cultivated for the local market. See **Papaya.**

Richard C. Schlesinger

Scientific classification. The American pawpaw belongs to the custard apple family, Annonaceae. Its scientific name is *Asimina triloba.* The papaya is in the papaya family, Caricaceae.

Pawtucket, *paw TUHK iht* or *puh TUHK uht* (pop. 72,958), is Rhode Island's fourth largest city. Only Providence, Warwick, and Cranston have more people. Pawtucket's name is an Indian word meaning *falls at the mouth of a river.* The city lies at the head of Narragansett Bay, about 5 miles (8 kilometers) northeast of Providence and about 40 miles (64 kilometers) southwest of Boston. It covers nearly 9 square miles (23 square kilometers) on either side of the Blackstone River. It is part of the Providence-Fall River (Massachusetts)-Warwick metropolitan area. For location, see **Rhode Island** (political map).

Samuel Slater, an English textile worker, set up the first cotton-spinning mill powered by water in the United States in Pawtucket in 1790. Today, the city's leading industries produce wire, cable, and jewelry. Pawtucket is the home of Hasbro, the largest toy manufacturer in the United States. The city also has factories for bleaching and dyeing cotton, for making cotton thread, and for weaving rayon goods. Machine shops produce machine tools, rolled steel, pressed metal products, hardware, nuts, bolts, and insulated wire. Other products made in Pawtucket include lace, shirts, hosiery, braid, chemicals, cement, paper and wood products, sports equipment, dental supplies, and computer-related items.

The original village was founded in 1671 by Joseph Jenks, Jr., an ironworker. The part of the city that lies on the east bank of the Blackstone River belonged to Seekonk, Massachusetts, until 1862. The section on the west bank of the river was part of North Providence until 1874. The two villages became the town of Pawtucket. A city charter was granted in 1885. Pawtucket has a mayor-council government. Stanford E. Demars

Pax Romana. See **Rome, Ancient** (The height of the empire).

Payne, John Howard (1791-1852), was the first American playwright to achieve international fame. However, he is best known for writing the words of the song "Home, Sweet Home." This song first appeared in his play *Clari, or the Maid of Milan* (1823).

Payne was born in New York City. His first play, *Julia, the Wanderer* (1806), was performed there when he was only 14 years old. At 17, Payne made his debut as an actor. He went to London in 1813 and lived there and in Paris until 1832. In London, Payne tried to establish himself as an actor but failed. He soon turned to playwriting.

Many of Payne's plays were unsuccessful, and he spent most of his life in debt. But he did achieve some popularity with his tragedy *Brutus, or the Fall of Tarquin* (1818) and other dramas. In 1823, while in London, Payne worked with the American writer Washington Irving on *Charles the Second, or The Merry Monarch* and several other productions.

Payne returned to the United States in 1832 and later became interested in the problems of American Indians. In 1835, he met with leaders of the Cherokee and published two letters in the *Knoxville* (Tennessee) *Register.* In the letters, he tried to persuade Congress to let the Cherokee continue living in the Southeast. His efforts failed. Payne served as U.S. consul in Tunisia from 1842 to 1845 and from 1851 until his death. Edward W. Clark

Payne-Gaposchkin, *PAYN guh PAHSH kuhn,* **Cecilia Helena** (1900-1979), was an English-born astronomer who became an authority on *variable stars* (stars that change in brightness) and the structure of the Milky Way Galaxy. She was one of the first women to advance to the rank of professor at Harvard University and the first woman to head a department there.

Cecilia Payne was born in Wendover. She graduated from Cambridge University in England in 1923. Later that year, she went to Cambridge, Massachusetts, where she studied at Radcliffe College and worked extensively at Harvard College Observatory. In 1925, she became the first woman to earn a doctorate in astronomy from Radcliffe. Her early work dealt with atmospheres of stars.

In 1934, Payne married the Russian-born Harvard astronomer Sergei Gaposchkin. They worked together on many variable star projects. Payne-Gaposchkin was a professor of astronomy at Harvard from 1956 to 1966. She was chairman of Harvard's Department of Astronomy from 1956 to 1960. Barbara L. Welther

Payton, Walter (1954-1999), a running back for the Chicago Bears, became the leading rusher in National Football League (NFL) history. In 1984, Payton broke Jim Brown's 12,312-yard career rushing record. He retired after the 1987 season with a career rushing total of 16,726 yards. In 1977, Payton rushed for 275 yards against the Minnesota Vikings, an NFL single-game record until Corey Dillon of the Cincinnati Bengals rushed for 278 yards in a game against the Denver Broncos in 2000. Payton stood 5 feet 10 inches (1.8 meters) tall and weighed about 200 pounds (90 kilograms). He was a strong, durable, versatile runner and pass receiver.

Walter Jerry Payton was born in Columbia, Mississippi. He was a star running back at Jackson State Univer-



Focus on Sports

Walter Payton became the leading rusher in NFL history in 1984. He broke Jim Brown's 12,312-yard career rushing record.

ity. He was selected by Chicago in the first round of the 975 college draft and spent his entire NFL career with Chicago. Payton died at the age of 45 of cancer complicated by a rare disease of the liver's bile ducts known as primary sclerosing cholangitis. Dave Nightingale

Paz, *pahs,* **Octavio,** *awk TAH vyoh* (1914-1998), a Mexican poet and essayist, won the 1990 Nobel Prize for literature. He was the first Mexican author to receive the prize. Paz's works reflect a range of influences, including Aztec mythology, Marxism, Asian philosophy, surrealism, and symbolism. Paz's collection *Liberty Under Oath* (1960) consists of poems written between 1935 and 1957. *The Collected Poems of Octavio Paz, 1957-1987* (1987) includes his well-known "Sunstone." This poem uses contrasting images to symbolize the inevitable loneliness of individuals and their search for union with others.

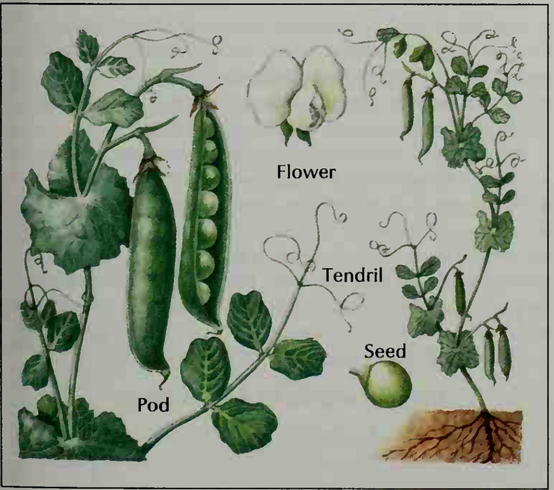
Paz wrote essays on many subjects, including anthropology, literature, philosophy, and science. *The Labyrinth of Solitude* (1950) is a collection dealing with the character of the Mexican people. In "The New Mexico" (1970), Paz analyzed civilization, language, and political protest. *El Mono Gramático* (1972) combines essay, narration, and poetry to give his views on life and art. His reflections on modern history appear in *One Earth, Four or Five Worlds* (1985). His essays on modern poetry were collected in *The Other Voice* (1991).

Paz was born in Mexico City. From 1962 to 1968, he served as Mexico's ambassador to India. Dick Gerdes

PCB. See **Polychlorinated biphenyl.**

Pea is a plant grown chiefly for its round edible seeds, which are also called peas. Cooked peas are a popular food. People also add peas to soups, salads, and casseroles. Peas are also used as feed for livestock. Peas are a good source of protein and vitamins A and C.

Pea plants have vines with soft stems that measure 6 inches to 6 feet (15 to 182 centimeters) long. Each leaf consists of one to three pairs of leaflets, and it ends in a curly thread called a *tendril.* Most pea plants have white flowers. Some have reddish-purple blossoms. Pea plants bear pods that contain four to nine or more seeds.



WORLD BOOK illustration by Jill Coombs

Pea plants are grown chiefly for their seeds, which are also called peas. Garden peas, *left,* have sweet, soft seeds. Field peas, *right,* have smooth, hard seeds.

Leading pea-growing states and provinces

Tons of peas grown in a year

State/Province	Tons of peas grown in a year
Minnesota	117,500 tons (106,600 metric tons)
Washington	104,200 tons (94,500 metric tons)
Wisconsin	92,600 tons (84,000 metric tons)
Oregon	46,600 tons (42,300 metric tons)
Ontario	40,800 tons (37,000 metric tons)
New York	36,800 tons (33,400 metric tons)

Figures are for a three-year average, 1997-1999.
Sources: U.S. Department of Agriculture; Statistics Canada.

Peas belong to a large family of plants called *legumes,* which produce pods. Other legumes include beans, peanuts, and alfalfa. See **Legume.**

Kinds of peas. There are two main types of peas, *field peas* and *garden peas.* Field peas have smooth, hard seeds that may be green, yellow, white, gray, blue, brown, or spotted. Some varieties of yellow and green field peas are marketed as *split peas* for making soup. Other varieties are used as fresh pasture for livestock, or are made into hay or silage. Garden peas generally have green, wrinkled seeds, though some varieties have smooth seeds. Garden peas are sweeter and softer than field peas and are popular with home gardeners. Varieties known as edible-podded peas are eaten with the pods and are often used in Asian cooking.

Growing peas. The pea plant is an *annual*—that is, it must be replanted each year. Peas require rich soil, constant moisture, and a cool growing season to develop well. In North America, most peas are grown in the northern United States and in Canada. Peas are planted in early spring and are harvested 60 to 70 days later.

Field peas are usually planted with a *grain drill,* a machine that drops the seeds and covers them with soil. They are harvested with a combine. Garden peas are usually planted and harvested by hand. They are planted 1 to 2 inches (2.5 to 5 centimeters) deep in rows 20 to 30 inches (51 to 76 centimeters) apart.

Diseases and pests. The most common diseases of pea plants are *leaf spot, stem blight, bacterial blight,* and *fusarium wilt.* Leaf spot, stem blight, and bacterial blight produce spots on the plants. Fusarium wilt restricts the growth of pea plants and makes them yellow. Scientists have developed varieties of peas that can resist these diseases. Leaf spot, stem blight, and bacterial blight can also be controlled with pesticides.

Pea plants are also attacked by such insect pests as *pea weevils, pea moths,* and *pea aphids.* Pea weevils and pea moths produce young that burrow into the pods and eat the seeds. Pea aphids damage a plant by sucking its juices and spreading virus diseases. Farmers control most of these pests with insecticides. Donald J. Reid

Scientific classification. Peas belong to the pea family, Fabaceae or Leguminosae. The scientific name for the garden pea is *Pisum sativum.* Field peas are *P. arvense.*

See also **Chickpea; Cowpea.**

Peace is the state of being calm, quiet, and free of disturbance. From a military and political point of view, peace means freedom from such violent disturbances as wars and riots. It does not mean total harmony among people. Even in peacetime, people take part in such forms of conflict as debates, lawsuits, sports contests, and election campaigns.

Throughout history, most people have wanted lasting peace. Religions and philosophers have called for the peaceful settlement of disagreements. The Bible declares, "Thou shalt not kill" and "Blessed are the peacemakers." Philosophers in ancient Greece and Rome taught brotherhood and nonviolence.

Yet since earliest times, the world has seldom had a long period of unbroken peace. Through the centuries, people have probably spent at least as much time at war as at peace. This article discusses past and present attempts to achieve lasting freedom from war.

Peacemaking efforts through the years

Ancient Greece and Rome. Ancient Greece consisted of many independent regions called *city-states.* The city-states frequently waged war on one another. As a result, several of them banded together and formed an organization that made one of the first attempts to limit warfare. This organization, called the Amphictyonic League, prohibited any member from destroying another or cutting off another's water supply.

Once every four years, the Olympic Games united the city-states. A truce created temporary peace throughout Greece so the games could take place. For a month, no one could bear arms or make war.

The Roman Empire maintained peace throughout a large part of the world during a period known as the *Pax Romana* (Roman peace). This peace lasted more than 200 years, from 27 B.C. to A.D. 180. During the Pax Romana, the Roman Empire extended over much of Europe, the Middle East, and northern Africa. At that time, no other nation was powerful enough to attack the Romans.

The Middle Ages. After the Roman Empire weakened during the A.D. 400's, small wars raged throughout Europe. The Christian church became the greatest force for peace. A church custom called the Truce of God limited fighting in private disputes to certain days of the week. A ruling called the Peace of God forbade fighting in such holy places as churches and shrines. But the church permitted "just" wars, such as those in defense of Christianity or a people's homeland.

From the 1400's to the 1700's, many people proposed various plans to achieve lasting peace. In the early 1600's, for example, the French statesman Maximilien de Béthune, Duke of Sully, developed a "Grand Design" for peace in Europe. Sully's plan called for the formation of a council of representatives of all European countries. The council would settle disagreements between nations.

In 1625, the Dutch statesman Hugo Grotius proposed international rules of conduct in a book called *On the Law of War and Peace.* For example, nations should guarantee certain rights to neutral nations, which took no part in a war. Grotius' ideas formed the basis of international law (see **International law**).

The Thirty Years' War ended in 1648 with the Peace of Westphalia. This treaty tried to ensure peace by establishing a *balance of power.* Such a plan maintains an even distribution of military and economic power among nations. As a result, no nation or group of nations is strong enough to conquer any other nation or group of nations. See **Balance of power.**

About 1647, the English religious leader George Fox founded the Society of Friends, most commonly known today as the Quakers. This group believed that the teachings of Jesus Christ prohibited war. Throughout their history, the Quakers have opposed war and supported peace movements. The Quaker leader William Penn, who founded the colony of Pennsylvania, proposed a peace plan similar to Sully's "Grand Design." Penn wrote a book called *An Essay Towards the Present and Future Peace of Europe* (1693). In it, he called for an international council to settle disputes between nations.

The *Project for Perpetual Peace,* written by a French clergyman, the Abbé Charles Irénée Castel de Saint-Pierre, was published in 1713. It called for a "Senate of Europe" composed of 24 delegates from the European nations. The French philosopher Voltaire criticized this plan because the member nations would have been monarchies. Voltaire believed the world could not have peace unless all nations became democracies.

The 1800's and early 1900's. In 1815, an American businessman, David L. Dodge, formed the New York Peace Society, the nation's first organization dedicated to preserving peace. Other *pacifist* groups followed, including the American Peace Society in 1828 and the Universal Peace Union in 1866.

During the 1800's, many international conventions discussed peacekeeping. Peace conferences met in London in 1843; in Brussels, Belgium, in 1848; in Paris in 1849; and in Frankfurt (am Main), Germany, in 1850. In 1898, Czar Nicholas II of Russia called for an international meeting to discuss arms limitation. As a result, conferences took place at The Hague in the Netherlands in 1899 and 1907. These conferences did not succeed in limiting armaments. But they did establish the Permanent Court of Arbitration to handle legal disputes between nations.

The Swedish chemist Alfred B. Nobel, who invented dynamite, regretted the wartime death and injury caused by his invention. In his will, he set up a fund to award annual prizes, including one for outstanding work in promoting world peace. The first Nobel Prize for peace was awarded in 1901 (see **Nobel Prizes**).

After World War I ended in 1918, a group of 42 governments established the League of Nations. This international association had the goal of maintaining peace throughout the world. Disputes between nations would be settled by the League Council or by *arbitration,* a decision by a third party. But the League of Nations had little power, partly because the United States and some other major nations never joined. In addition, League members failed to cooperate with one another.

Current efforts to ensure peace

Since the end of World War II in 1945, many attempts have been made to assure lasting peace among all nations. The major forms of these efforts have included (1) diplomacy, (2) international organizations, (3) arms control, (4) collective security, and (5) improvement of international communication and trade.

Diplomacy involves *negotiations* (discussions) between two or more nations. Most governments have diplomats who serve as their representatives in other countries to promote international cooperation and harmony. Other peace efforts depend largely on successful diplomacy. Many political experts rate diplomacy as the most important factor in peacekeeping. See **Diplomacy**.

International organizations work for the peaceful settlement of disagreements between nations. In 1945, 50 countries created the United Nations (UN), the major international organization dedicated to world peace. The League of Nations was dissolved in 1946.

The UN Security Council investigates quarrels between nations and suggests ways of settling them. If any nation endangers the peace, the council may use economic *sanctions* (penalties) against it. For example, member nations might stop trading with the offender. If such measures fail, the council may ask UN members to furnish troops to enforce its decision. The UN has achieved some success in keeping the peace. But it has failed to prevent local wars in several regions, including Africa, Southeast Asia, and the Middle East.

Arms control involves control, reduction, or elimination of certain armed forces or weapons. In 1968, the UN approved a *nonproliferation treaty* to stop the spread of nuclear weapons. This treaty, which took effect in 1970, bars the nuclear powers from giving nuclear weapons or knowledge to other nations. The UN also won approval of arms-control treaties in the 1970's. One treaty banned the production and stockpiling of biological weapons. The United States, Russia, and other nations have agreed to observe limits on the production and possession of nuclear weapons. In 1993, over 120 countries signed a UN-sponsored treaty banning the manufacture, use, transfer, and stockpiling of chemical weapons. The treaty took effect in 1997. See **Arms control**.

Collective security resembles the balance of power system. Each member of a group of nations agrees to come to the aid of any other member if that nation is attacked. The combined strength of the group discourages attacks. Such groups include the North Atlantic Treaty Organization (NATO).

Improvement of international communication and trade increases understanding among nations. It reduces the danger of war by lowering the cultural and economic barriers that divide countries. Many European nations work together in a group called the European Union. This organization works to improve the flow of goods, ideas, and people from nation to nation and to achieve greater economic and political cooperation among its members. Robert J. Art

Related articles in *World Book* include:

Arbitration
Biological Weapons Convention
Chemical Weapons Convention
Conscientious objector
Hague, The
International relations
Kellogg-Briand Pact
League of Nations
Nuclear Nonproliferation Treaty
Pacifism
United Nations
War (How wars end)

Additional resources

Mays, Terry M. *Historical Dictionary of Multinational Peacekeeping.* Scarecrow, 1996.
Melko, Matthew. *Peace in Our Time.* Paragon Hse., 1990.

Peace Bridge is a symbol of the years of friendship between the peoples of the United States and Canada. It extends 5,800 feet (1,768 meters) across the Niagara River from Fort Potter, in Buffalo, New York, to Fort Erie, Ontario. A company with 9 Canadian and 16 American directors owns the steel bridge. Peace Bridge opened on Aug. 7, 1927. Fred F. Videon

Peace Corps is an overseas volunteer program of the United States government. Men and women in the Peace Corps work with people in developing countries to help them improve their living conditions. The chief goals of the corps are (1) to help the poor obtain everyday needs, (2) to promote world peace, and (3) to increase understanding between Americans and the people of other nations.

The Peace Corps was established in 1961. In 1971, it became part of ACTION, a government agency that combined several volunteer programs. In 1981, the Peace Corps became an independent agency. In 2002, it became part of the USA Freedom Corps, an umbrella group for several national service organizations.

How the corps works. The Peace Corps selects, trains, and supports American men and women for two years of service. It sends people into a country only at the request of that nation. Corps members are called *volunteers,* and the country in which they serve is called the *host country.* The Peace Corps consults the government of the host country in deciding what projects to undertake and what skills to seek when choosing volunteers. Most projects are designed to raise the living standards of people who live in villages. The corps works to improve agriculture, health care, and educa-



Peace Corps

A Peace Corps medical volunteer helps this Moroccan boy recover from leg injuries. Medical volunteers work to improve health care in the areas they serve.

tion in the host country. It also promotes local leadership and local management of community resources and helps develop small businesses.

Volunteers serve in Africa, Asia, Eastern Europe, and Latin America and on various islands in the Pacific Ocean. They live and work with people of the host country. The most important part of their work consists of training the people to do the job that the volunteers are doing. For example, a Peace Corps carpenter may teach people construction skills as he or she works.

The Peace Corps cooperates with volunteer organizations of other countries and with the United Nations Volunteer Program. The corps also works with various private organizations in the United States. For example, the Peace Corps Partnership Program works with American schools, civic organizations, youth groups, and other private organizations. Under this program, the corps arranges for the construction of a clinic, school, or other community facility in the host country. The project is then financed by the participating organization.

Choosing volunteers. To qualify for service in the Peace Corps, a person must be a U.S. citizen and at least 18 years old. The corps has no upper age limit. Married couples may volunteer if both the husband and wife have skills the corps can use in the same country.

The Peace Corps seeks dedicated individuals who can learn skills and work effectively with people. Volunteers must be able to adapt to cultures and living conditions widely different from those in the United States. Members of the corps vary greatly in abilities and background. Most are college graduates, but the corps does not require applicants to have college training. Applicants who have experience in agriculture, medicine, and certain other fields receive special consideration.

All applicants for service with the Peace Corps fill out a detailed application form. They list their educational and work background, skills, special interests, and hobbies. Applications may be obtained by writing to the Peace Corps, Washington, DC 20526. In choosing volunteers, the corps uses the information on the application form, together with references from the applicant's employers, friends, and teachers.

Volunteers receive from 8 to 14 weeks of training. Most of them train in the host country, but some attend a Peace Corps training center in the United States. Trainees study the culture, history, and language of the country in which they will serve. They also receive technical training for their specific assignments.

Members of the Peace Corps receive an allowance for living costs and are provided with housing, medical care, and transportation. After returning to the United States, they receive a readjustment allowance of $200 for each month of service.

History. The idea of an "army" to work for peace was first suggested by the American philosopher William James in 1904. James made the proposal in a speech in Boston and, in 1910, developed the idea more fully in a pamphlet. He suggested forming a youth peace army to handle important but dangerous civilian projects.

After World War II ended in 1945, many private groups set up international work camps. Others sent young Americans to share their skills with students and workers in other countries. These groups followed the example of the American Friends Service Committee, a Quaker organization, which started its first international projects in 1917.

In January 1960, Senator Richard L Neuberger of Oregon and Congressman Henry S. Reuss of Wisconsin asked Congress to study the possibilities of a youth corps program. Later that year, Senator Hubert H. Humphrey of Minnesota proposed that Congress create a peace corps. Then, Senator John F. Kennedy of Massachusetts used the proposal for a peace corps in his 1960 presidential election campaign. Kennedy declared: "There is not enough money in all America to relieve the misery of the underdeveloped world in a giant and end-

ACTION



Peace Corps volunteers work with people in developing countries to help them improve their living conditions. Most volunteers train in the country where they will serve. This picture shows Peace Corps members studying a local language in Congo (Kinshasa).



Peace Corps

An agricultural volunteer helps a farmer improve his crop production. This volunteer soil conservation expert counsels a Guatemalan farmer on pest control. Together, they worked to wipe out an infestation of parasitic worms that attacked his Chinese cabbage.

ss soup kitchen. But there is enough know-how and nowledgeable people to help those nations help themelves."

Kennedy was elected president in November 1960, nd he established the Peace Corps on March 1, 1961. he first volunteers started training at Rutgers University New Brunswick, New Jersey, that same year. Sargent hriver was the first director of the Peace Corps.

Many thousands of Americans have served as Peace orps volunteers in dozens of countries. The United tates also supported the efforts of other nations to set p similar organizations.

Service programs in other countries. Agencies milar to the Peace Corps have been set up by Ausalia, Austria, Belgium, Canada, Denmark, Finland, rance, Israel, Japan, Korea, Liechtenstein, the Netherınds, New Zealand, Norway, the Philippines, Sweden, aiwan, and the United Kingdom. These organizations ary in several ways, including name, size, and length of ervice. But all of them, like the Peace Corps, enlist volnteers from among their citizens to serve in other ountries.

Several nations also have national volunteer corps at work within their own countries. In some cases, embers of these organizations work with Peace Corps ersonnel. Critically reviewed by the Peace Corps

See also **ACTION**; **Latin America** (Latin America and e United States); **Shriver, Sargent.**

Additional resources

anerjee, Dillon. *So, You Want to Join the Peace Corps...What to Know Before You Go.* Ten Speed, 2000.
offman, Elizabeth C. *All You Need Is Love: The Peace Corps and the Spirit of 1960s.* Harvard Univ. Pr., 1998.

eace of... See articles on peace agreements listed un-er their key word as in **Utrecht, Peace of.**

eace pipe, also called *calumet, KAL yuh meht,* was a eremonial tobacco pipe that North American Indians smoked as a sign of peace and friendship. They passed it from one person to another. Among the Indians of the Great Lakes, Mississippi Valley, and Great Plains, this pipe had a stone bowl and a long wooden stem elaborately decorated with feathers. Early French explorers called the pipe and the dance held in its honor the *calumet,* from their word for the reed that sometimes formed the stem of the pipe. Most Indian pipes were not peace pipes. Indians of many tribes smoked solely for pleasure. Other pipes were used only in religious ceremonies. W. Roger Buffalohead

See also **Arapaho Indians.**

Peace River, in western Canada, is the largest tributary of the Mackenzie River. It is 945 miles (1,520 kilometers) long, including the length of its main branch, the Finlay. It drains the Peace River district, a fertile farming area in northwestern Alberta and eastern British Columbia. For location, see **Alberta** (physical map).

The Peace River is formed where the Finlay and Parsnip rivers join in central British Columbia. It cuts through the Rocky Mountains and flows in a general easterly direction for about 300 miles (480 kilometers). At the town of Peace River in Alberta, where the Smoky River joins it, the river turns and flows north through steep sandstone cliffs. The riverbed then gradually widens and becomes more shallow until the stream enters the Slave River 815 miles (1,310 kilometers) from its source at Finlay Forks.

Williston Lake, formed by the W.A.C. Bennett Dam across the Peace River, is the largest body of fresh water in British Columbia. It covers 680 square miles (1,761 square kilometers).

During the early fur trade, the Peace River was part of a major freight route. A railway built from Edmonton, Alberta, after World War I (1914-1918) opened the Peace River district. Grande Prairie, Alberta, is now the center of this area. Some of the world's finest hard northern wheat comes from the Peace River district. This district

is the northernmost commercial crop-producing area in North America.

Vast pools of oil and natural gas lie beneath the Peace River district. Pipelines transport these minerals to Edmonton, and on to Vancouver, B.C. Natural gas refined at Taylor Flats is sent through a 650-mile (1,050-kilometer) pipeline to southern British Columbia and the United States. G. Peter Kershaw

Peach is a roundish, yellow to reddish, edible fruit. It has a hard, deeply pitted stone. Its flesh may be soft or quite firm. Among *deciduous* (leaf-shedding) tree fruits, only the apple and the pear are more widely distributed throughout the world than the peach. Peach trees grow in most temperate regions.

Horticulturists (plant scientists) believe that China is the native home of the peach. They believe the trees grew there at least 4,000 years ago. The peach was spread throughout Europe by the Romans. Spanish explorers brought the peach to the Americas as early as the 1500's, and English colonists also brought peaches in the 1600's. The United States is the world's leading producer of peaches. Many peach trees are planted in commercial orchards, and some are cultivated in gardens as ornamentals.

Peach trees grow 15 to 25 feet (4.6 to 7.6 meters) high. Their slender leaves have toothed edges. Flowers appear before the leaves. The delicate pink blossoms may be large and showy, but sometimes are quite small. They appear early in the spring and can be injured by late frosts. Most commercial peach orchards are located in regions where there are few late frosts. Clear, hot weather during the growing season is best for peaches. They are grown southward from the Great Lakes region of the Midwest into the Deep South, and along the Atlantic and Pacific coasts.

Cultivars. There are many *cultivars* (varieties produced by selective breeding) of peaches. They ripen from early summer to fall—some as late as October. Peaches are called *freestone* or *clingstone,* according to how difficult it is to remove the pit from the fruit. The fruit of freestone peaches is usually softer than that of clingstones. But some cultivars of clingstones are very mellow, with fine aroma and excellent texture.

Perhaps the best-known peach cultivar is Elberta, a freestone. It originated in 1870 in Marshallville, Ga. Other well-known freestone cultivars are J. H. Hale, Redhaven, Hiley, Halehaven, July Elberta, and Golden Jubilee. Important clingstone cultivars include Fortuna, Paloro, Johnson, Gaume, and Sims. Nectarines are similar to peaches. The two fruits are essentially alike except for the skins, and the trees are identical (see **Nectarine**).

Growing peach trees. Most commercially important cultivars of peach are reproduced by attaching a bud of the desired cultivar to a rootstock from a different cultivar. This procedure is called *budding.* Rootstock cultivars are chosen on the basis of their ability to produce stronger or dwarf-type trees. One-year-old rootstocks are budded in late summer. The newly budded trees lie dormant until the next spring, when the buds are forced into growth. The age of a peach tree is determined by the age of the bud even though the rootstock is one year older.

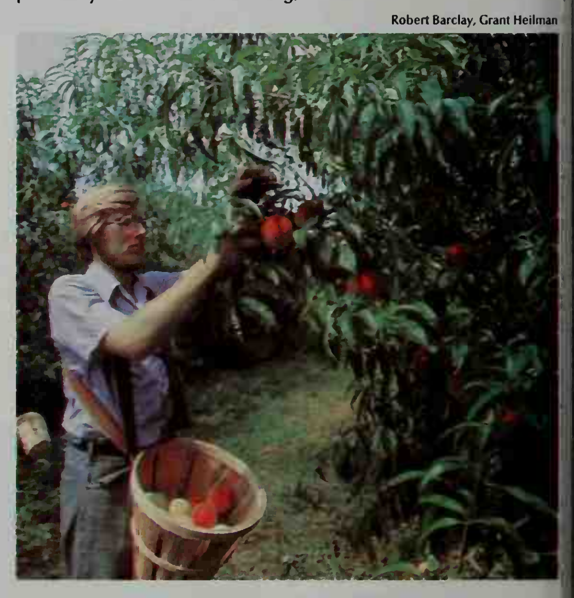
Cultivation. Peach trees grow best on a deep, well-drained, medium-textured soil, such as a sandy loam.



WORLD BOOK illustration by Kate Lloyd-Jones, Linden Artists Ltd.

The peach is a tasty fruit that has a hard, pitted stone, *above.* The fruits develop from the pink blossoms of the peach tree. The peaches that are to be sold as fresh fruit generally are picked by hand to avoid bruising, *below.*

Robert Barclay, Grant Heilman



Growers plant standard-sized trees 18 to 25 feet (5.5 to 7.6 meters) apart in the orchard. But those trees grown on dwarfing rootstocks are planted 12 to 15 feet (3.7 to 4.6 meters) apart. A peach orchard begins to bear large crops about 3 or 4 years after it is planted. If the trees are healthy, they live about 20 years. They reach peak production when they are 8 to 12 years old. A single tree may produce from 4 to 10 bushels (87 to 220 kilograms) of peaches.

Peach trees must be watered regularly. The amount of water required varies with climate, soil texture and depth, and depth of the root system. Enough water must be used to wet the entire root system. Cultivation of the orchard is necessary to destroy weeds, which compete with the trees for water and mineral nutrients in the soil. Chemical sprays are often used to control weeds.

Peach trees need various mineral nutrients for normal

growth. Most of these occur in sufficient quantity in the soil. But usually nitrogen must be added. Special fertilizers are used to supply this element.

Pruning is essential for good fruit production. Peach trees are pruned more heavily than most other fruit trees. Trees are pruned low to make spraying and picking easier. Because the fruit is produced on shoots of the previous season's growth, about a third of the last year's growth is kept. All the rest is cut off. The trees produce so many peaches that the fruit must be thinned. Growers remove some peaches early in the season. This technique increases the size and improves the quality of the fruit that remains. Tree-ripened peaches have the best flavor. They are harvested when ripe but still firm.

Uses. Fresh peaches are eaten as a delicacy. But many of the fruits are canned, principally those of the clingstone cultivars. Some peaches are frozen for commercial use, and a few of the fruits are dried. Pastries and preserves can be made from peaches. Distillers sometimes make brandy from them.

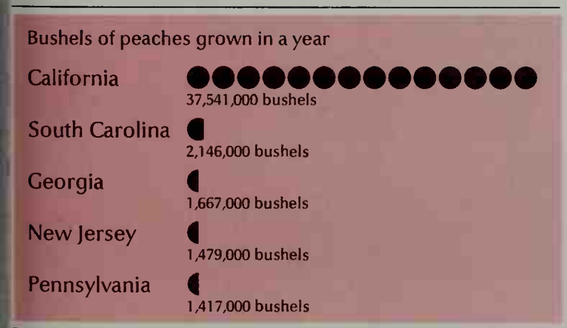
Diseases. A number of diseases attack the peach. *Brown rot,* a fungus, causes serious damage. It rots the fruit and prevents the flowers from opening. *Peach leaf curl* is very troublesome. To prevent this disease, growers spray the tree early in spring before the leaves emerge. Other fungi cause *mildew, rust,* and *blight.* Sprays of organic chemical fungicides are used to control these diseases.

Peach trees are susceptible to many virus diseases. Among the serious ones are *peach yellows, X-disease, Western X-disease, ring spot,* and *peach mosaic.* Trees infected with these diseases must be uprooted.

Insects. Several insects damage peach trees. The *peach twig borer,* the larva of a moth, may bore into the fruit. But usually it bores into the trunk and branches, sometimes killing the tree. The peach moth larva destroys twigs and fruit. Many other moth larvae and beetles prey on the foliage, as do several kinds of caterpillars. Organic chemical insecticide sprays are used to control insects. Some chemicals for disease and insect sprays may be combined.

Production. Peaches are grown throughout the world. The leading peach-growing countries are, in order of production, China, the United States, Italy, and Greece. About three-fourths of the peaches grown in the United States come from California. Clingstone cultivars make up about two-thirds of California's peach crop. California's rate of production varies little, but

Leading peach-growing states



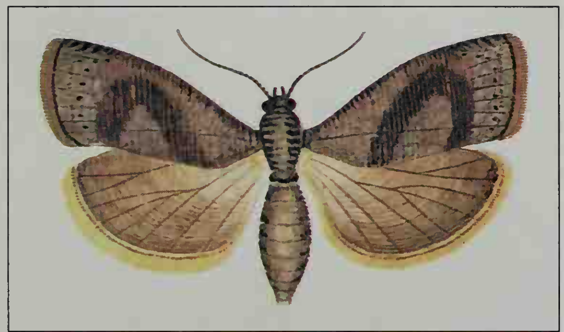
One bushel equals 48 pounds (22 kilograms). Figures are for a three-year average, 1996-1998.
Sources: U.S. Department of Agriculture; Statistics Canada.

weather conditions affect production in other peach-growing states. Ontario leads the Canadian provinces in peach production. The province grows about 85 percent of Canada's total crop. James E. Pollard

Scientific classification. The peach tree belongs to the rose family, Rosaceae. Its scientific name is *Prunus persica.*

See also **Fruit** (table: Leading fruits in the United States).

Peach moth is a small, mottled brown moth. It is also called the *Oriental fruit moth.* It is one of the most serious pests of peaches. The peach moth winters as a larva in a cocoon under loose bark or trash. The adults



WORLD BOOK illustration by John F. Eggert

The peach moth damages peaches and other fruits.

emerge when peaches are blooming. They lay eggs on leaves, and the eggs hatch into larvae. From 4 to 7 generations of larvae appear yearly. The first generation eats tender twigs. Later generations of peach moth larvae feed upon the fruit.

The peach moth also attacks apples, pears, quinces, cherries, and plums. Parasitic wasps and flies, including some imported from abroad, provide aid in controlling the moth. A synthetic *pheromone* is sometimes sprayed on peach orchards to keep peach moths from mating (see **Pheromone**). Insecticide sprays may be needed to control large numbers of the moths. John R. Meyer

Scientific classification. The peach moth belongs to the family, Tortricidae. It is *Grapholita molesta.*

See also **Codling moth.**

Peach State. See **Georgia.**

Peacock, also called *peafowl,* is one of the showiest of all birds because of its great size and the beauty of its feathers. Technically, the word *peacock* refers only to the male peafowl. The female bird is called a *peahen.* However, most people use the term *peacock* for either sex.

The Indian peafowl is the best-known species. The male is about as large as a turkey. It has a metallic greenish-blue neck and breast, purplish-blue underparts, and a long train of greenish feathers brilliantly marked with bold spots that look like eyes. These feathers grow from the back and not the tail. During courtship, the male bird spreads the train into a gorgeous fan as he parades slowly in front of the female. The female bird is smaller and less vividly colored than the male bird. The female bird has no train.

Indian peafowls live wild in India and Sri Lanka, and can be seen in city parks and on country estates. The dark-green, broken coloration may have protective



P. Berger, NAS

A male peacock can spread the feathers on its back into a beautiful fan. These feathers, called a *train,* are about five times as long as the bird's body.

value in the midst of colorful tropical foliage. These birds eat snails, frogs, and insects, as well as grain, juicy grasses, and bulbs. They often destroy crops. Varieties with white plumage are sometimes found in captivity. The green "jungle" peafowl, found in Burma, Malaysia, and Java, has a golden-green neck and breast.

Tame peacocks may be found in all parts of the world. The young cannot stand the changeable weather of temperate climates very well, and are hard to raise. The hen makes its nest in a protected spot on the ground. It lays 10 or more brownish eggs.

In ancient times, the peacock was carried to all parts of the world as a great treasure. During the reign of Solomon, "once in three years came the navy of Tharshish, bringing gold and silver, ivory, and apes, and peacocks" (I Kings 10: 22). The peacock is mentioned in *The Birds,* a play by Aristophanes, written in Greece during the 400's B.C. Pliny speaks of it as common in his day in Rome, where the peacock was considered a great delicacy as a roast, served in its own feathers.

Scientific classification. Peacocks belong to the family Phasianidae. The Indian peafowl is *Pavo cristatus.* The green peafowl is *P. muticus.* John W. Fitzpatrick

Peafowl. See Peacock.

Peale was a family of famous American artists. At least 20 members of the family, covering three generations, were artists. Charles Willson Peale (1741-1827), the enthusiastic family patriarch, believed that anyone could learn to draw. He taught many of his 17 children and also his brother James Peale (1749-1831). James in turn taught five of his children. James painted portraits, figure compositions, landscapes, and still lifes. They were done with the directness and charm that mark the best work of the family.

Raphaelle Peale (1774-1825) and Rembrandt Peale (1778-1860) are the best known of Charles Willson Peale's artist sons. Raphaelle is noted for his still lifes and miniatures. Rembrandt painted hundreds of portraits. Sarah Miriam Peale (1800-1885), a daughter of



Oil painting on canvas (1770-73; 1808); the New-York Historical Society, New York City

Charles Willson Peale painted this picture of his family after studying under Benjamin West in London.

.mes, was probably the first professional woman por-
ait painter in America.

Charles Willson Peale gave up painting in middle age
devote almost full time to his natural history museum
Philadelphia. At the museum, he often displayed one
f his most startling lifelike pictures, *The Staircase
'roup* (1775), which has life-sized portraits of his sons
tian and Raphaelle. Elizabeth Garrity Ellis

See also **Lafayette, Marquis de** (picture); **Maryland**
/luseums).

eale, Norman Vincent (1898-1993), an American
ergyman, won fame for his writings and his radio and
levision programs. Believing that one of the main tasks
f religion is to help people, Peale wrote several books
n the topic. They include *The Power of Positive Think-
g* (1952) and *The Tough-Minded Optimist* (1961). He
dited a magazine, *Guideposts,* and a newspaper col-
nn, "Confident Living."

Peale was born in Bowersville, Ohio. He became a
inister of the Methodist Episcopal Church in 1922. In
)32, he became pastor of the Marble Collegiate Re-
rmed Church in New York City. He became semire-
red in 1984. Charles H. Lippy

eanut is a plant species grown mainly for its fruit. The
eanut is a *legume*—that is, it bears fruit in the form of
ods (shells) that contain one or more seeds. The peanut
more closely related to peas than to nuts. There are
vo seeds in most peanut pods. These tasty seeds are
also called peanuts. They are a favorite food, whether eaten alone or mixed into candy, cookies, or pies. Peanut butter is also a popular food. Worldwide, peanuts are grown chiefly for oil.

The peanut plant is unusual because its pods develop underground. For this reason, peanuts are often called *groundnuts.* Other names for peanuts include *arachides, goobers, mani,* and *pinders.*

Peanuts are an important crop, especially in the warm regions of the world. Farmers in Africa and Asia grow about 90 percent of the world's peanuts. The leading peanut-growing countries are China, India, Indonesia, Nigeria, and the United States. Georgia produces more peanuts than any other U.S. state—about 40 percent of the country's annual peanut crop.

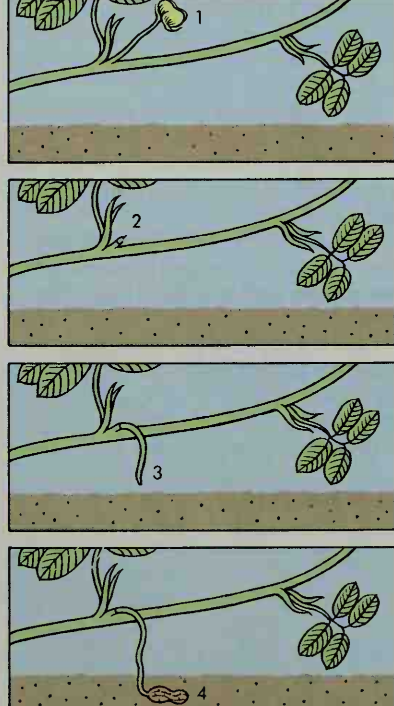
Peanuts are a nutritious food. There are more energy-giving calories in roasted peanuts or peanut butter than in an equal weight of beefsteak.

Uses of peanuts

As food. Manufacturers roast peanuts inside the pods and sell them as whole *roasted-in-shell* peanuts. In addition, they remove the shells and roast and sell only the seeds. Manufacturers usually salt peanuts to improve their flavor.

Manufacturers make *peanut butter* by roasting and *blanching* (removing the skins or seed coats from) the peanuts, and then grinding them into a thick paste. Pea-

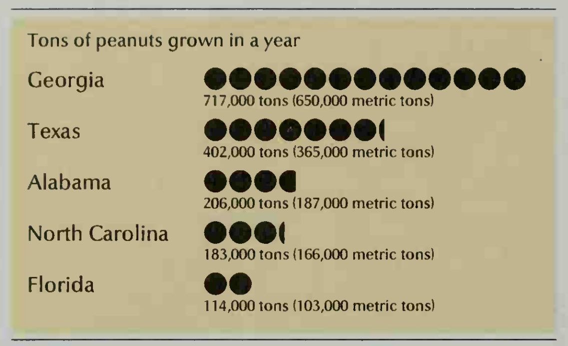




WORLD BOOK illustrations by James Teason

Peanuts grow underground. Flowers open at dawn (1), wither, and finally fall off (2). The base of each fertilized flower then begins to grow (3), forming a *peg* (stalklike stem). The peg pushes down into the ground. Its tip swells and grows into a peanut pod (4).

Leading peanut-growing states



Figures are for a three-year average, 1996-1998.
Source: U.S. Department of Agriculture.

nut butter is eaten alone and in sandwiches. About half of the peanuts consumed in the United States are eaten as peanut butter. About a fourth are sold as roasted peanuts.

Roasted peanuts are eaten alone or mixed into candies, cookies, pies, and other bakery products. Some ice cream is flavored with peanut butter. *Peanut bread* is made from ground peanuts. Peanut bread is rich in proteins and low in starch. Peanuts are sometimes sold fresh as *boiled peanuts.* Instead of drying the peanuts after picking, farmers wash the peanuts and boil them in salt water.

Peanut seeds consist of almost 50 percent oil. Peanut oil is used to fry foods. It smokes only at high temperatures and does not absorb odors easily. Many salad oils and dressings, margarine, and other vegetable shortenings also contain peanut oil.

In industry. Low grades of peanut oil are used as an ingredient in soaps, face powders, shaving creams, shampoos, and paints. They are also used in making *nitroglycerin,* an explosive. Peanut oil has also been tested as an alternative fuel source.

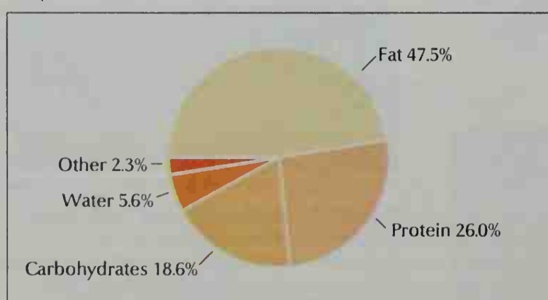
The solid that remains after the oil is removed from peanuts is a high-protein livestock feed. Peanut protein can also be used to make a textile fiber that is called *Ardil.*

Even the shells of peanuts have uses. Manufacturers grind the peanut shells into powder. This powder is an ingredient in plastics, cork substitutes, wallboard, and abrasives.

On farms. Peanut foliage makes good hay. But most

Food value of the peanut

Raw peanut with skins



Source: U. S. Department of Agriculture.

farmers return the harvested plants to the ground to fertilize the soil.

Growing peanuts

The peanut is grown as an annual crop. It can grow up to 2 $\frac{1}{2}$ feet (75 centimeters) high and from 3 to 4 feet (90 to 120 centimeters) across. Peanut plants range in type from *bunch* plants to *runner* plants. Bunch plants grow upright. Runner plants spread out on or near the ground as they grow. Growers group peanuts into four market types: (1) large-seeded Virginias; (2) smaller-seeded Virginias, called *runners;* (3) Spanish; and (4) Valencia. Both kinds of Virginias include bunch and runner plants. Spanish and Valencia types are bunch.

Peanut plants bear many small, yellow, pealike flowers where the leaves are attached to the stems. The plants blossom continuously for two to three months. Flower buds open at sunrise. Fertilization takes place during the morning, and the flowers usually wither and die about noon. Within a few days, the *pegs* (stalklike stems of the pods) begin to grow. They grow slowly at first, but gradually grow more rapidly.

The pegs grow downward and push into the soil to a depth of 1 to 3 inches (2.5 to 8 centimeters). The grown pegs may be about 7 inches (18 centimeters) long. The tips of the pegs contain the developing seeds. They swell and mature into peanut pods. Most pods contain two seeds, but some may contain only one or as many as five seeds.

Cultivation. Peanut plants grow best in light, well-drained, sandy soil. They need much sunshine, warm temperatures, moderate rainfall, and a frost-free growing period of four or five months.

Farmers prepare the soil by plowing it deeply and thoroughly. Loose soil is important so that the pegs can penetrate the soil easily. Farmers plant peanut seeds 2 to 3 inches (5 to 8 centimeters) deep at intervals of 3 to 6 inches (8 to 15 centimeters), and in rows 24 to 36 inches (60 to 90 centimeters) apart.

Farmers must harvest peanuts at exactly the right time. If they harvest their peanut crops too early, many of the pods will not have ripened. If they harvest their crops too late, the pegs may snap, and many of the pods will be left in the soil. Most of the pods ripen 120 to 150 days after planting.

At harvest time, farmers use mechanized diggers to slice through the *tap* (main) root of each plant below soil level. The plants, with pods attached, are dug from the soil and turned upside down to dry in the sun. Special machines called *peanut combines* remove the pods from the sun-dried plants. The pods are further dried artificially in wagons. The pods are cleaned and graded before they are shelled for processing.

Processing peanuts

Most shelled peanuts are either *oil roasted* or *dry roasted.* Oil roasting is the more widely used method. In this process, manufacturers blanch the peanuts and fry them in oil. Dry-roasted peanuts are glazed with oil, sprinkled with salt, and roasted in large ovens.

Over 60 percent of the world's peanut production is used to produce oil. Some processors use a chemical *solvent* to dissolve oil from the peanuts. The oil is recovered from the solution by evaporation. In another



Grant Heilman

armers harvest peanuts with a *peanut combine.* The com-
ine picks up the plants after they have been dug, strips the
ods from them, and places the pods in a large collecting bin.

nethod, peanuts are ground and pressed in large tube-
haped grinders. The oil is collected, filtered, and de-
dorized. The *peanut meal* left over after the oil is ex-
racted is sometimes ground into peanut flour. In some
ountries, people eat peanut meal as a high-protein
neat substitute.

History

Peanuts are native to South America. South American
ndians were growing peanuts at least 1,000 years ago.
arly North American settlers grew peanuts, but no one
nows whether peanuts were cultivated in North Ameri-
a before the settlers arrived. Early colonists fed peanuts
) hogs. Peanut growing increased rapidly during and
fter the American Civil War. But peanuts did not be-
ome an important commercial crop until about 1917.

George Washington Carver made an extensive study
f peanuts. Carver is credited with having found more
nan 300 uses for the plant and its fruit. See **Carver,
eorge Washington.**

Since the 1930's, peanut yields in the United States
ave increased dramatically. In Georgia, for example, the
verage yield per unit of peanut farmland is about five
mes greater today than it was in the 1930's.

William D. Branch

Scientific classification. Peanuts belong to the pea family,
abaceae or Leguminosae. Cultivated peanuts are *Arachis hy-
ogaea.*

ear is a fleshy fruit. Some pears are large and round at
ne blossom end and taper inward toward the stem.
)thers may be almost completely round, like an apple,
r as small as a cherry. The pear tree is closely related to
ne apple and the quince. It grows in temperate regions
nroughout the world. The *common,* or *European,* pear
native to southern Europe and Asia. The *Japanese* and
hinese pears, often called *oriental* pears, are descend-
d from the wild *sand* pear of central and western Chi-
a. There are many hundreds of pear varieties.

The fruit is covered with a smooth, thin skin, which
nay be yellow, russet, or red. Its juicy flesh is sweet and
ellow. It is also tender, though tiny, hard grit cells
nake the flesh of some pears taste sandy. European
ears contain only a few of these cells. But other pears
nay have large numbers of them. Enclosed in the center of the fleshy portion is a core much like the core of an apple. This core may contain as many as 10 seeds.

The common pear tree may grow 45 feet (14 meters) high and be 25 feet (8 meters) wide. It sometimes lives to be quite old, often more than 75 years. Its leaves are almost oval but have a sharply pointed tip. They usually have toothed edges and prominent veins. The white flowers grow in clusters of 4 to 12 blossoms.

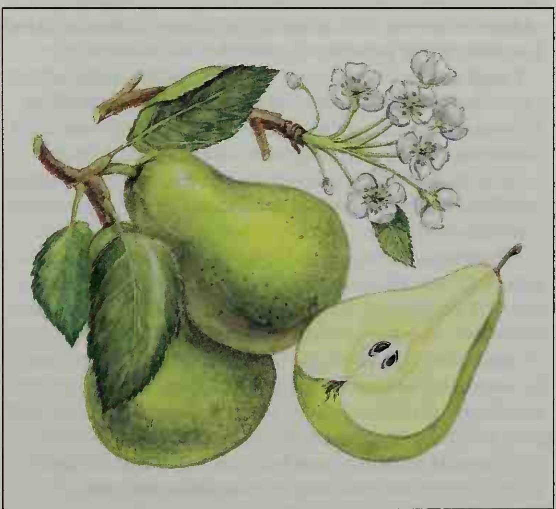
How pears are grown. Pears, like most other fruit trees, are grown by grafting the desired variety on a rootstock. Seedlings of European pears are usually used for rootstocks. They are called French pear seedlings, even though the seeds are no longer imported from France. Growers obtain most of the seed used for these seedlings from pear canneries. The seeds are usually from Bartlett pears.

Quince rootstock is used to produce dwarf pear trees. But some European pear varieties will not grow on quince. Then the grower uses an intermediate stock. To do this, the grower first grafts the intermediate stock, which will grow on the quince. When the intermediate stock shoots are long enough, the European variety wanted is grafted to the shoot. Then the grower cuts off all side growth except that on the last graft.

Growers plant standard-sized trees about 18 to 25 feet (5 to 8 meters) apart. They plant dwarf trees about 10 to 15 feet (3 to 4.6 meters) apart. Pear trees grow well in soils heavier and wetter than those in which peach trees will grow. Sometimes fertilizers are added to the soil to increase the tree's growth. In some regions, certain varieties may not need cross-pollination to bear fruit. But in other regions, the same varieties may need to be cross-pollinated. Some varieties always need cross-pollination.

Growers prune pear trees as they do some other orchard fruit trees. They cut off unnecessary branches so light can reach all parts of the tree. They also keep the tree quite low to make it easier to spray and pick fruit.

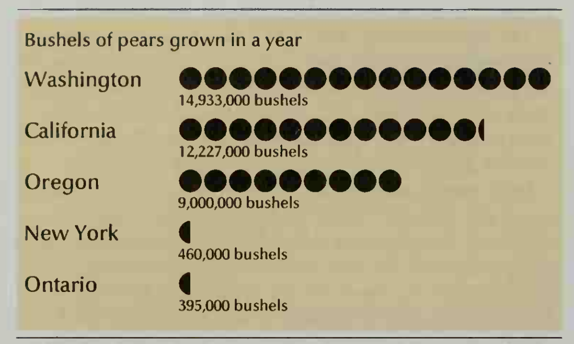
Some pear trees seem able to withstand very cold weather. Therefore, certain varieties can be grown in regions with severe winters. However, many pears thrive



WORLD BOOK illustration by Kate Lloyd-Jones, Linden Artists Ltd.

Pears vary in shape, but they are generally round at the bottom and narrow near the stem. The flesh is sweet and juicy.

Leading pear-growing states and provinces



One bushel equals 50 pounds (23 kilograms). Figures are for a three-year average, 1996-1998.
Sources: U.S. Department of Agriculture; Statistics Canada.

in hot, dry areas. These varieties are grown in many Pacific Coast States of the United States. Hybrids produced from common and Japanese pears are quite hardy.

Varieties. From the common, or European, pear have come such familiar varieties as Bartlett, Comice, Anjou, Bosc, Hardy, Seckel, and Winter Nelis. Because of the gritty nature of the fruit of some older varieties, which is objectionable to many people, oriental pears were crossed with the common pear. From this cross-breeding come the varieties Kieffer, LeConte, and Garber. But some extremely fine varieties of oriental pears have become available and are grown in the Pacific Coast States.

Bartlett pears ripen in summer, but most other varieties ripen later, usually in early fall. Oriental pears ripen well on the tree. Other pears ripen to perfection only when they are removed from the tree. Therefore, these pears are picked while they are still green and hard. The fruit will ripen in a cool place where the temperature does not exceed 75 °F (24 °C). Many varieties, such as Winter Nelis and Forelle, can be kept in cold storage all winter. Temperatures range between 32 °F (0 °C) and 40 °F (4 °C). Most other pears, such as Comice and Anjou, must be removed from storage by midwinter.

Uses. Pears are used widely as a dessert fruit. About half of all pears grown are eaten fresh. But many are canned alone or with other fruits. Some pears are dried. Europeans use pears for pear cider, called *perry.*

Food value. Fresh pears contain about 14 percent carbohydrates and a small amount of protein and fats. They also contain calcium, phosphorus, iron, vitamin A, thiamine, riboflavin, niacin, and ascorbic acid. Pears have as many calories as apples, but more calories than peaches. Pears have fewer calories than either plums or cherries.

Diseases. Perhaps the greatest limiting factor in growing the common pear is the occurrence of fire blight. This disease is often called *pear blight* because pears are so susceptible to it. Fire blight is a destructive disease that spreads rapidly in warm, humid weather. It is caused by bacteria that attack blossoms, young twigs, and branches, killing them and turning them black, as if they had been burned by fire. The bacteria live from year to year in cankers on the tree trunk and limbs. Insects carry them from tree to tree. Rain, dripping through the tree, carries them from branch to branch. Contaminated pruning tools also spread the disease. Growers prune away all the diseased parts as soon as they are noticed. The growers also spray the tree with a copper solution, or with solutions containing antibiotics such as terramycin and streptomycin. Other damaging diseases include false fire blight, leaf spot, pear decline, powdery mildew, scab, and collar rot.

Insects. The codling moth is a serious pest. It causes wormy fruit. Pear psylla affects the skin of the fruit and the tree's foliage. Pear-leaf blister mite and various other mites cause brownish blisters on the undersides of the leaves. They also cause the fruit to be small and to fall. Pear thrips attack the buds early in spring, causing them to shrivel and turn brown. Other pests include aphids, leaf rollers, lygus bugs, midges, oriental fruit moths, scale insects, slugs, and stink bugs.

Production. The leading pear-growing countries are, in order of production, China, Italy, and the United States. About 95 percent of the annual U.S. pear crop comes from the Pacific Coast States of California, Oregon, and Washington. Bartlett pears make up about 60 percent of the total U.S. crop. Ontario and British Columbia are the leading pear-growing provinces of Canada.

History. No one knows when pears were first found. The Greek poet Homer, who may have lived during the 700's B.C., mentioned this fruit in his works. So did the Roman playwright Publilius Syrus.

The pear has been grown in America since the earliest colonists arrived. In 1630, John Endecott (or Endicott) of Massachusetts is supposed to have planted the *Endicott pear,* which is famous in the history of horticulture. Most pears in colonial America came from France, then the center of European pear growing. One of the largest pear trees in the world once grew in the Mississippi Valley, near the French settlement of Cahokia. Pear growing spread throughout the United States. Pears are grown in gardens and farms in almost every state. However, the pear has never become as popular as the apple.
Fenton E. Larsen

Scientific classification. The pear tree belongs to the rose family, Rosaceae. The common, or European, pear is *Pyrus communis.* Most oriental pears are *P. pyrifolia.* Others are the Ussurian pear, *P. ussuriensis,* and the Callery pear, *P. calleryana.*

See also **Blight**; **Fruit** (table: Leading fruits).

Pearl is one of the most valuable gems. Large, perfectly shaped pearls rank in value with the most precious stones. But pearls are different from other gems. Most gems are minerals mined from beneath the earth. But pearls are formed inside the shells of oysters. Mineral gems are hard and usually reflect light. However, pearls are rather soft, and they absorb, as well as reflect, light.

How pearls are formed

Oysters and other shell-forming mollusks make a special substance, called *nacre* (pronounced *NAY kur),* that lines the insides of their shells. This smooth lining is called the *nacreous layer,* or *pearly layer,* and it is often lustrous. It is formed by cells from a fleshy body organ called the *mantle.* When a foreign substance, such as a bit of shell or a tiny parasite, enters the mollusk's body, the mantle cells begin to work. They cover the invading substance with thin sheets of nacre. They build successive circular layers of nacre until the foreign body is enclosed in the shell-like substance, forming the pearl.

The pearl has the same luster and color as the lining of the shell of the mollusk. But few pearl-forming mol-

lusks produce the beautifully colored nacre that is essential for valuable pearls. Valuable pearls come from some species of oysters and other mollusks that live in tropical seas. Some species of mussels found in rivers also produce precious pearls. Edible clams and oysters have dull shells, so their pearls are without luster. As a result, they have no value as gems.

Characteristics of pearls

When a pearl is cut in two and examined under a microscope, the layers can be seen. Because the layers are *concentric* (formed in a complete circle around the central substance), the cut pearl looks like a sliced onion. The layers are made up of little crystals of a mineral substance called *aragonite,* a form of calcium carbonate. They are held in position by a cartilagelike material known as *conchiolin* (pronounced *kahng KY oh lin*). The tiny mineral crystals overlap and break up any light that falls on them into little rainbows of color. This gives pearls their iridescence, which jewelers call *orient.*

Conches, clams, and most edible oysters usually do not make pretty pearls because their aragonite crystals are too large. Even though the pearls may be of beautiful pink, white, or purple color, they lack iridescence.

Color. Oriental pearls, so called not because they come from the Far East but because they are iridescent, may also have color. These pearls may be "black," pink, orange, gold, cream, or white. "Black" pearls are really a dark gray. They are among the most valuable pearls.

Shape of a pearl is as important as its color. Round pearls, suitable for necklaces, are the most valuable. Next are button-shaped and drop-shaped pearls. These are often used for earrings. Matched pairs of these pearls are even more valuable than pairs of unmatched single ones. Pearls with irregular shapes are called *baroques.* They are less valuable than the others. Pearls made by a kind of snail called the *abalone* have wonderful color and luster but are almost never symmetrical.

Blemishes. Perfect pearls and pearls with only one blemish are the most valuable. Sometimes blemishes can be removed if the flaw is not too deep. Specially trained workers called *peelers* carefully scrape away the blemished layers. When they have removed the flaw, the pearl is smaller, but perfect. Such a pearl is worth more than the original large, but blemished, pearl.

Matching pearls. The matching of pearls to make a pair or a string makes the finished piece more expensive than the total cost of the individual pearls. Each added pearl must be like all the others in color and orient. Often it must be of the same size as the others. It must have no more than one tiny blemish. One blemish is acceptable because the pearl can be drilled for mounting at the blemish. Before people began to produce cultured pearls, it could take many years to fill a necklace of matched pearls.

Value. The cost of pearls sold in large quantities is determined by their weight. In a piece of jewelry, the value of a pearl is determined by its size, color, and luster. For example, matched pearls in a necklace cost more than the total of their individual values.

Kinds of pearls

Natural pearls. Until the 1940's, the chief pearl-oyster beds were found in the Persian Gulf, near the island



Jack Fields, Photo Researchers

A pearl forms inside the shell of an oyster, *above.* The pearl begins when a particle of foreign matter enters the shell. Over a period of years, the oyster covers the particle with many thin layers of a substance called *nacre,* forming the pearl, *below.*

WORLD BOOK illustration by Patricia Wynne

Prismatic layer
Lamellar layer
Nacreous layer
Layers of nacre
Particle
Mantle
Epithelium sac

country of Bahrain. Other natural pearl-oyster beds were located in the South Pacific Ocean. Thousands of oysters had to be collected to produce even a small handful of pearls. For this reason, natural pearls were extraordinarily expensive. Today, few natural pearls are harvested for jewelry because the farming of cultured pearls produces pearls more cheaply.

Cultured pearls are real pearls made by oysters. They usually can be distinguished from natural ones only by tests made in laboratories. The cultured pearl has a larger central body around which the layers of nacre form. The cultured pearl also has fewer and thicker layers of nacre. Thicker layers of nacre increase the value of the pearl.

Cultured pearls were first produced by inserting in an oyster a bead made of *mother-of-pearl,* the nacre secreted by certain inedible clams and oysters (see **Mother-of-pearl**). A small amount of mantle tissue from another oyster also was inserted. The process was developed by Kokichi Mikimoto of Japan in the early 1900's. So successful was this process that the cultured-pearl business became much larger than the trade in natural pearls. Today, most cultured pearls are produced in Japan.

To produce cultured pearls, young oysters are planted in carefully selected oyster beds. When the oysters are 3 years old, they are taken from the beds to special



Robert A. Isaacs, Photo Researchers

Production of a cultured pearl begins when a worker inserts a tiny pellet made from nacre or mussel shell into an oyster. The oyster then makes the pearl.



Frederick Ayer, Photo Researchers

The shape of a pearl helps determine its worth. The three round pearls at the top are more valuable than the six irregularly shaped pearls below them.



Paolo Koch, Photo Researchers

A worker sorts pearls by size, arranging them in a special grooved box. Later, holes will be drilled into the pearls and they will be strung into necklaces.

production plants. There, trained people open the oysters' shells and insert tiny pellets made of nacre or made from mussel shells. The workers then place the oysters in wire cages that will protect them from enemies. The cages are suspended from rafts and lowered into calm, protected waters near the shore.

Twice a year attendants raise the cages and remove seaweed and barnacles from the oysters. Progress of the oyster and the care given it are recorded on small metal tags attached to the cage. From one to three years after the pellets and tissue are inserted, the oyster is removed from the cage and its shell is opened. There is a valuable pearl in about 1 out of every 20 oysters opened. The pearl is washed, graded, and polished before it is sent to the market.

Imitation pearls are manufactured. Usually, manufacturers coat glass beads with a substance known as *pearl essence*. This substance, sometimes known by its French name *essence d'orient*, is a creamy liquid extracted from fish scales. Herring scales usually furnish the main ingredient. Imitation pearls can be recognized by the little loose flaps of dried pearl essence surrounding the hole. Often, a little of the glass bead that the pearl essence has failed to cover can be seen at this place on the pearl.

Care of pearls

Because pearls are soft, they are easily scratched by such hard gems as diamonds. Pearls should always be put away carefully, out of contact with other jewelry. Pearls contain an organic material, conchiolin. This material dries out in time, or it can be destroyed by high temperatures. The aragonite crystals that make up the layers of nacre dissolve very quickly in acid. Perspiration sometimes contains acid. Therefore, jewelry made of pearls should be washed and dried gently after it is worn. Richard J. Hoffmann

Related articles in *World Book* include:

Birthstone
Button
Carbonate
Conch
Gem (picture)
Mollusk
Oyster

Pearl Harbor was the site of a surprise attack on the United States by Japanese military forces on Dec. 7, 1941. Japanese ships and airplanes attacked the United States naval base at Pearl Harbor on the island of Oahu in Hawaii. The attack caused heavy casualties and destroyed much of the American Pacific Fleet. The attack also brought the United States into World War II. "Remember Pearl Harbor" became the rallying cry for the country. American participation was a crucial reason why the embattled Allied nations, including the United Kingdom (U.K.) and Soviet Union, turned the tide and defeated the Axis nations, headed by Japan and Germany.

Background. Japan began a military expansion during the 1930's. It invaded China and much of Southeast Asia. Japan wanted to acquire the rich resources of Asia. The United States protested this aggression. It demanded that Japan stop its actions, but Japan ignored the demand. The United States then cut off exports to Japan. Japan had few natural resources, and it relied on exports of petroleum and other goods from the United States.

General Hideki Tojo became premier of Japan in October 1941. Tojo and other Japanese military leaders realized that only the United States Navy had the power to block Japan's expansion in Asia. They decided to try to cripple the U.S. Pacific Fleet at anchor in Pearl Harbor.

The attack. On December 7, the U.S. secretary of state conferred with two Japanese diplomats in Washington. While they talked, the Japanese military had already launched the attack on the U.S. facilities at Pearl Harbor. In the United States, the attack became known as the "Pearl Harbor sneak attack."

On December 7, Vice Admiral Chuichi Nagumo led a

33-ship Japanese striking force that steamed under the cover of darkness to about 230 miles (370 kilometers) north of Oahu. Early in the morning, his aircraft carriers launched 350 airplanes against the United States Fleet. The first bombs fell at about 7:55 a.m. The chief targets were 8 battleships among the 180 American vessels anchored in the harbor. The attack killed 2,388 people at Pearl Harbor and wounded about 2,000. It destroyed or damaged 21 American ships and more than 300 planes. The Japanese lost 29 aircraft.

On December 8, Roosevelt addressed Congress. He called December 7 "a date which will live in infamy." Congress declared war on Japan. In a radio speech the same day, Roosevelt urged Americans to back the war effort and avenge Pearl Harbor. He said, "Every single man, woman, and child is a partner in the most tremendous undertaking of our American history."

At the time of the attack, Nazi Germany had taken over much of Europe. The U.K. and the Soviet Union provided the main resistance to the Nazis. The United States had stayed out of the war. However, under the leadership of President Franklin D. Roosevelt, it provided extensive aid to Britain. Germany declared war on the United States on December 11.

Japan won many battles and gained much territory in the early days of U.S. participation in the war. However, a massive effort to produce equipment and supplies built American military strength, and the slogan "Remember Pearl Harbor" helped boost the morale of the population. The Allies gradually turned the tide against Japan and Germany. The long war, which had begun in 1939, ended in 1945 with the surrender of the Axis countries.

The war memorials. The ships destroyed in the Pearl Harbor attack include the U.S.S. *Arizona.* The battleship sits upright on the bottom of the harbor with more than 1,000 men entombed aboard. The U.S.S. *Arizona* Memorial, a roomlike structure, stands above the ship. The memorial is supported by pilings that reach the harbor bottom. About 1 $\frac{1}{2}$ million people visit the memorial each year. The names of those who died on the *Arizona* are carved in marble at one end of the room. Even today, bubbles of oil from the sunken *Arizona* rise to the water's surface. In 1999, the U.S. battleship *Missouri* was opened to the public, as the Battleship *Missouri* Memorial, in Pearl Harbor near the *Arizona.* This ship was the one on which the Japanese surrendered to the Allies, on Sept. 2, 1945.

Pearl Harbor as a naval base. In 1887, King Kalakaua of Hawaii gave the United States the right to develop a coaling station at Pearl Harbor. The harbor's name came from the pearl oysters that once grew in its waters. The United States made its first attempt to deepen the channel through the reef outside the harbor in 1902. The first dry dock was completed in 1919.

Pearl Harbor is now the site of the Pearl Harbor Naval Complex. It covers about 12,600 acres (5,100 hectares) on Oahu Island. Five major fleet commands in the Pacific have headquarters at the base. Paul W. Doerr

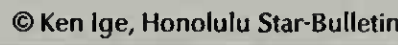
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Yamamoto, Isoroku

Additional resources

Kimmett, Larry, and Regis, Margaret. *The Attack on Pearl Harbor.* Rev. ed. Navigator, 1999.
Prange, Gordon W., and others. *At Dawn We Slept: The Untold Story of Pearl Harbor.* Rev. ed. Viking Penguin, 1991.
Rice, Earle, Jr. *The Attack on Pearl Harbor.* Lucent Bks., 1996. Younger readers.

Pearson, Karl (1857-1936), a British geneticist, helped develop the science of statistics. He was noted for applying his statistical methods to biological data. In 1884, Pearson became professor of mathematics at the University of London. There he wrote his famous *Grammar of Science* (1892), a general textbook on scientific method. Later, Pearson developed an interest in biology and *eugenics,* the application of the science of breeding to improve the genetic quality of human beings. Pearson was born in London. Joseph W. Dauben



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Pearl Harbor tributes honor the U.S. military personnel who died in the surprise Japanese attack on Pearl Harbor Naval Base on Dec. 7, 1941. The U.S.S. *Arizona* Memorial, *foreground,* stands above the submerged battleship *Arizona.,* where more than 1,000 men are entombed. The U.S.S. *Missouri,* on which the Japanese surrendered on Sept. 2, 1945, towers above the memorial.

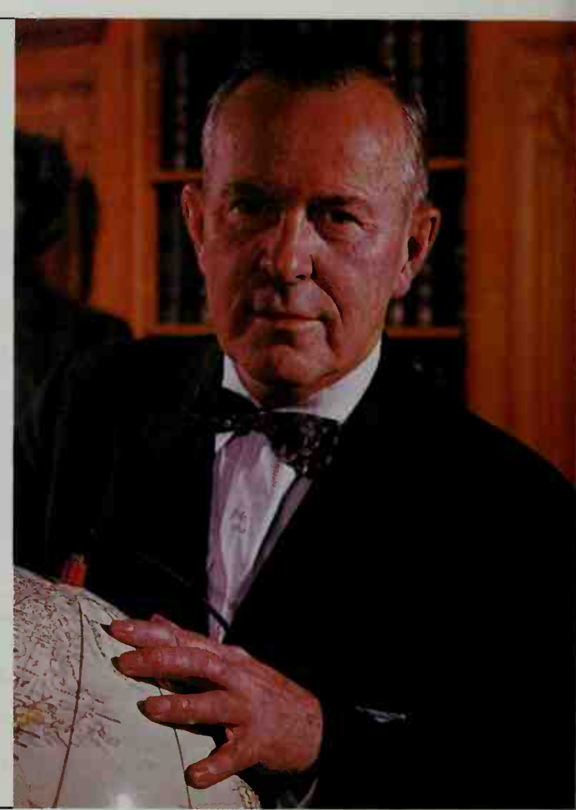
Lester B. Pearson

Prime Minister of Canada
1963-1968





Diefenbaker 1957-1963 | Pearson 1963-1968 | Trudeau 1968-1979



Philippe Halsm

Pearson, Lester Bowles (1897-1972), a former baseball and hockey player and university professor, served as prime minister of Canada from 1963 to 1968. He succeeded John G. Diefenbaker, whose Conservative government fell during a dispute between Canada and the United States. Diefenbaker had refused to allow atomic warheads on defense missiles provided by the United States. Pearson, a Liberal, believed that Canada had agreed to accept the warheads and should do so. Pearson resigned as prime minister in 1968. He was succeeded by Pierre Trudeau, the minister of justice in Pearson's Cabinet.

Long before taking office as prime minister, Pearson had won fame as an international statesman. He was the first Canadian to receive the Nobel Peace Prize. As Canada's secretary of state for external affairs, Pearson had helped establish the North Atlantic Treaty Organization (NATO), an alliance of Western nations. He also served on a United Nations commission that drew up cease-fire plans in the Korean War. Pearson then became president of the UN General Assembly. He later played a leading role in ending a war in Egypt over control of the Suez Canal.

At the UN and NATO, Pearson showed great ability at working behind the scenes to put ideas into action. He could work with people of any temperament. He eased many tense moments with a well-chosen remark. The public became familiar with Pearson's sporty bow ties and his nickname, "Mike." However, Pearson had a deep personal reserve that people found difficult to penetrate.

When Pearson became leader of the Liberal Party in 1958, one newspaper described him as "eloquent as a professor of algebra." Pearson admitted that he lacked the ability to inspire audiences with speeches. He spok with a slight lisp, which hurt his efforts to impress his listeners. He worked hard to make himself a better pub lic speaker, but did not enjoy making speeches.

"There are some things in politics I don't like, never have liked, and never will like," Pearson said. "The hoopla, the circus part of it, all that sort of thing. It still makes me blush."

Early life

Boyhood. Lester Bowles Pearson was born on April 23, 1897, in Newtonbrook (now part of Toronto), Ont. H was the son of Edwin Arthur Pearson, a Methodist min ister, and Annie Sarah Bowles Pearson. His father's father also had been a minister. Lester had an older brother, Marmaduke, and a younger brother, Vaughan Edwin Pearson had a great interest in sports, especiall baseball, and passed his enthusiasm on to Lester. The boy became a star athlete. He also was an excellent stu dent.

Education and war service. In 1913, Pearson entered the University of Toronto. He majored in history. World War I began in August 1914. The following March, at the age of 17, Pearson enlisted in the Canadian Army Medical Corps as a private. He completed h training in England and was sent to Thessaloniki, Greece, in 1915. He served in the Balkan area of southeastern Europe for a year and a half.

While Pearson was serving as a stretcher-bearer, some wounded British soldiers called the youth "Mike" because he looked Irish, and the nickname stayed with him. In 1917, Pearson received a lieutenant's commission in the infantry. That same year, he transferred to the British Royal Flying Corps as a pilot with the rank of flight lieutenant. Canada had no air corps at the time. Pearson returned to Canada in April 1918 because of injuries he suffered after being struck by a bus in London. He served for the rest of the war as a ground instructor at a Canadian base of the Royal Flying Corps.

After World War I ended in November 1918, Pearson returned to the University of Toronto. He graduated with honors in 1919. He then studied law for several weeks in Toronto. Next, Pearson took a job stuffing sausages in the Hamilton, Ontario, plant of Armour and Company, a meat-packing firm. During this period he played semiprofessional baseball. He then worked as a clerk in Armour's Chicago plant.

In 1921, Pearson received a scholarship from the Massey Foundation, which sent Canadians overseas to study. He studied history at Oxford University in England from 1921 to 1923. Pearson starred on Oxford's hockey team and played on the British Olympic team. He received a bachelor's degree and a master's degree from Oxford. From 1923 to 1928, he taught history as a lecturer and then as an assistant professor at the University of Toronto.

On Aug. 22, 1925, Pearson married Maryon Elspeth Moody (1902-1989) of Winnipeg, Manitoba. She had been one of his students at the university. The Pearsons had two children—Geoffrey Arthur Holland Pearson, who became a Canadian foreign service officer, and Patricia Lillian Pearson. Maryon Pearson disliked public life. But she was proud of her husband and anxious for his success, and she played an active role in his election campaigns. Pearson once declared: "I couldn't have carried on without her."

Public career

Early diplomatic service. A great turning point in Pearson's life came in 1928. He entered the diplomatic service during the administration of Liberal Prime Minister W. L. Mackenzie King, and served as a first secretary in the department of external affairs.

From 1930 to 1935, during the administration of Conservative Prime Minister R. B. Bennett, Pearson took part in several international conferences. Bennett particularly praised Pearson for his work on two Canadian economic commissions. Pearson received the Order of the British Empire, an award for public service from the British government.

King returned to power as prime minister in 1935. For six years, Pearson served as first secretary in the Canadian high commissioner's office in London. He returned to Ottawa in 1941 and for one year was assistant undersecretary of state for external affairs. In 1942, King assigned Pearson to the staff of the Canadian embassy in Washington, D.C.

In 1943, Pearson headed a United Nations commission on food and agriculture. This work led to the creation of the UN Food and Agriculture Organization in 1945. As chairman of another UN committee in 1943, he helped organize the UN Relief and Rehabilitation Administration (UNRRA). Pearson represented Canada at UNRRA meetings in 1944, 1945, and 1946. In January 1945, King appointed him Canadian ambassador to the United States. Pearson held this post until October 1946, when he returned to Ottawa as undersecretary of state for external affairs.

Pearson served as senior adviser of the Canadian delegation to the San Francisco conference that signed the United Nations Charter in June 1945. The Western nations favored him to be the first UN secretary-general, but the Soviet Union vetoed him.

Secretary of state for external affairs. In September 1948, Pearson was appointed secretary of state for external affairs of Canada. Canadian Cabinet members must be members of Parliament, so Pearson ran for a seat in the House of Commons the following month. The district of Algoma East in Ontario elected him to the House of Commons, and he won reelection in succeeding elections through the years. As Canada's secretary of state for external affairs, Pearson headed most of his country's delegations to the UN General Assembly from 1948 to 1956. King retired in November 1948, and Louis St. Laurent succeeded him as Liberal Party leader and prime minister.

In April 1949, Pearson represented Canada at ceremonies setting up NATO. He had been one of the principal architects of the alliance. Pearson emphasized that NATO, although it was established to ward off Communism, must also work for social, economic, and political progress. "Our treaty," Pearson declared, "is ... the point from which we start for yet one more attack on all those evil forces which block our way to justice and peace."

Pearson attended many other international conferences as part of his duties. He placed great importance on relations between developed countries, such as Canada, and less developed nations, such as India. He also worked to strengthen the nonmilitary aspects of NATO. In addition, Pearson tried to improve the UN. He served as president of the UN General Assembly in 1952 and 1953.

In October 1956, France, the United Kingdom, and Israel invaded Egypt, which had seized the Suez Canal. The UN accepted Pearson's proposal to set up an emergency military force to end the fighting and supervise a cease-fire. The UN troops quickly restored peace before the fighting could turn into a major war. On Oct. 14, 1957, Pearson became the first Canadian to receive the Nobel Peace Prize.

Liberal Party leader. In 1957, St. Laurent's government fell to the Conservatives, led by John G. Diefenbaker. After resigning as prime minister, St. Laurent also stepped down as Liberal Party leader. Pearson quickly decided to run for party leader. Although some Liberals considered him to be too inexperienced in domestic affairs, his fame as a statesman and his popularity in Parliament brought him victory in the race. The Liberal Party chose Pearson as its leader by a large majority in January 1958.

"No one ever started off worse than I did," Pearson said later. His advisers persuaded him to seek a parliamentary vote of no confidence in the new Conservative government. Pearson demanded that Prime Minister Diefenbaker return the government to the Liberals without an election. This demand gave Diefenbaker, a mas-

ter of parliamentary maneuvering, a chance to attack Pearson and the Liberals. Diefenbaker then dissolved Parliament and called an election in March 1958. Under Pearson, the Liberals went down to one of their worst defeats in history. They won only 49 of the 265 seats in the House of Commons.

After some initial discouragement, Pearson organized his tiny forces to mount an increasingly strong attack on the Diefenbaker government. While sharply criticizing the government in Parliament, Pearson and other Liberals also reorganized their party to give it a progressive and decisive image. These developments helped increase the popularity of the Liberal Party. In addition, the Diefenbaker government was handicapped by high unemployment in Canada.

As a result of Pearson's vigorous leadership, the Liberals doubled their parliamentary strength in the June 1962 elections. The Conservatives fell short of an absolute majority in Parliament, but they still had more seats than any other party.

Prime minister. Early in 1963, a dispute over defense policy strained relations between Canada and the United States. The question was whether Canada had agreed in 1959 to accept atomic warheads for missiles supplied by the United States. Pearson and the Liberals contended that Prime Minister Diefenbaker should accept the warheads, but Diefenbaker refused to do so. The Conservative government fell apart, with three ministers resigning, and was defeated by a vote of no confidence taken in February 1963.

In the elections of April 1963, the Liberals won 129 seats in the House of Commons, four short of an absolute majority. However, the small opposition parties promised to support Pearson. The Progressive Conservatives won only 95 seats, and Diefenbaker resigned.

Important dates in Pearson's life

1897 (April 23) Born in Newtonbrook (now part of Toronto).
1925 (Aug. 22) Married Maryon Elspeth Moody.
1945 Became ambassador to United States.
1945 Attended San Francisco conference on UN charter.
1948 Became secretary of state for external affairs.
1948 Elected to Canadian House of Commons.
1949 Represented Canada at signing of NATO pact.
1951 Elected chairman of NATO Council.
1952 Elected president of UN General Assembly.
1956 Helped end Suez Canal crisis.
1957 Received Nobel Peace Prize.
1958 Elected leader of Liberal Party.
1963 (April 22) Became prime minister of Canada.
1968 (April 21) Resigned as prime minister of Canada.
1972 (Dec. 27) Died in Rockcliffe Park, Ont.

Highlights during Pearson's career



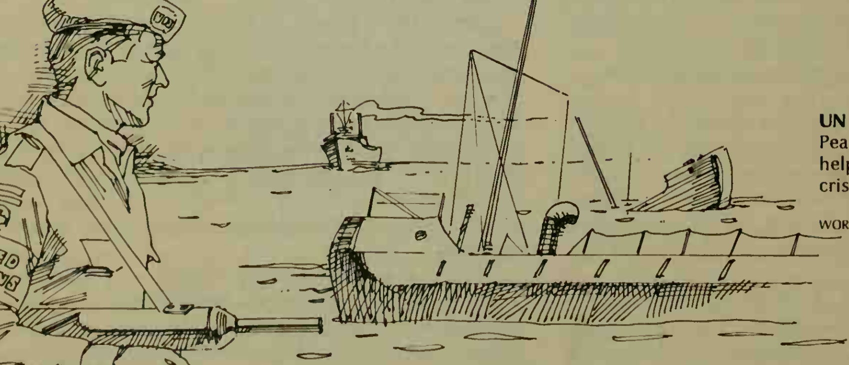
UPI/Bettmann Newsphotos

As ambassador to the U.S., Pearson, *left,* met with U.S. official George Summerlin.



UPI/Bettmann Newsphoto

The Nobel Peace Prize was presented to Pearson, *left,* in 1957.



UN troops, sent to Egypt on Pearson's recommendation, helped end the Suez Canal crisis in 1956.

WORLD BOOK illustration by Tak Murakami

Pearson became prime minister of Canada on April 22, 1963.

Pearson worked quickly to improve Canadian relations with Britain and the United States. He accepted nuclear warheads from the United States and took action to save a stalled treaty concerning the Columbia River. Pearson got along well with President John F. Kennedy of the United States, but he was less happy with Kennedy's successor, President Lyndon B. Johnson. The United States became increasingly involved in the Vietnam War during the mid-1960's. Pearson believed the war would end badly for U.S. foreign policy, and he urged the United States to seek a peaceful solution to the conflict.

Pearson faced serious domestic problems when he became prime minister. Disputes between French-speaking and English-speaking Canadians threatened national unity. Many French Canadians complained that they did not have equal opportunities and rights. One organization, the Quebec Liberation Front, demanded independence from Canada for the province of Quebec. This secret terrorist group used bombings and other forms of violence against the national government. Fortunately for Pearson, the Canadian economy boomed during the 1960's. This prosperity permitted his government to provide increased social services.

In 1965, Pearson called a national election because he wanted an absolute Liberal majority in the House of Commons. He kept control of the government, but the Liberals failed to win a majority.

In April 1968, at the age of 71, Pearson resigned as prime minister and as head of the Liberal Party. Pierre Trudeau succeeded Pearson. In August 1968, Pearson became head of a World Bank commission. The commission was set up to assist the economic progress of developing countries.

Pearson remained in good health until 1970, when he had an operation for cancer that resulted in the removal of an eye. He died of cancer at his home in the Ottawa suburb of Rockcliffe Park on Dec. 27, 1972. He was buried near Wakefield, Quebec. Robert Bothwell

See also **Canada, History of; Prime minister of Canada.**

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United Press International

As President of the UN General Assembly, Pearson worked with UN Secretary-General Dag Hammarskjöld, *left.*



Wide World

Pearson's wife, Maryon, took an active part in her husband's election campaigns despite her dislike of politics.



UPI/Bettmann Newsphotos

As prime minister, Pearson met with President John F. Kennedy, *right,* in Hyannis Port, Massachusetts, and agreed to accept atomic warheads from the United States. This agreement helped ease the strain in relations between the two countries that had centered around this issue.

Peary, *PEER ee,* **Robert Edwin** (1856-1920), was an American Arctic explorer. Along with Matthew Henson, Peary is generally credited with the discovery of the North Pole in 1909.

Early life. Peary was born in Cresson, Pennsylvania, and raised in Maine. He graduated from Bowdoin College in 1877 and joined the United States Navy as a civil engineer in 1881. In 1886, the Navy assigned Peary to survey a canal route across Nicaragua. Peary hired Henson in 1887 as an assistant for this assignment.

Arctic expeditions. Early polar explorers had searched across the region for a Northwest Passage that would allow ships to sail between the Atlantic and Pacific oceans. But in Peary's time, explorers of several nations were competing to be the first to reach the North Pole. Each new record of "farthest north" achieved by explorers created international excitement. Peary was determined to win the race.

To reach the pole, explorers would have to overcome a number of obstacles. These difficulties included the bitterly cold temperatures, the hazards of a shifting ice pack, and impassable open channels of water called *leads* between drifting masses of ice. To have adequate supplies, explorers would have to haul *sledges* (heavy sleds) themselves or use dogs to help.

Peary began his first Arctic journey in the summer of 1886 to investigate the prospects for reaching the North Pole from northern Greenland. After only about three weeks, however, Peary was forced to turn back. In 1891, Peary led a major expedition to Greenland. The expedition included Henson; Peary's wife, Josephine; and his future rival Frederick A. Cook. The trip lasted 13 months. During it, Peary proved that Greenland is an island.

Peary and Henson made long dog sled trips over the polar icecap on several more expeditions (1893-1895, 1898-1902, and 1905-1906). By learning from the Inuit about proper dog handling, clothing, diet, and survival techniques, Peary became an expert Arctic traveler.

A number of wealthy Americans established the Peary Arctic Club to support Peary's expeditions. In 1904, the club commissioned a special ship, the *Theodore Roosevelt,* for his use. The *Roosevelt* sailed on Peary's 1905-1906 trip, during which the explorers achieved a new record for "farthest north" at 87°6' north latitude.



Bettmann Archive

Robert E. Peary won fame as a great Arctic explorer. This photograph shows him after he returned from an expedition in 1909. Peary is usually credited with having discovered the North Pole on the expedition.

"The Pole at last." Peary sailed to Cape Sheridan on Ellesmere Island in the Canadian Arctic in September 1908. He then established his supply base at Cape Columbia at the island's northern tip. Peary's main party left Cape Columbia on March 1, 1909. The group included 24 men, 19 sledges, and 133 dogs. They faced over 400 miles (640 kilometers) of broken and drifting ice to reach the pole. The group was delayed several times by having to wait for leads to freeze before they could continue. Several support teams helped Peary on the journey's early stages, then returned to base after leaving food at various points for the return trip. Robert A. Bartlett led the last support party and left Peary, Henson, and four Inuit about 140 miles (225 kilometers) from the pole.

With 40 dogs and five sleds, the men left on April 2 for the final assault on the pole. On April 6, Peary calculated that he had reached the North Pole. The explorers began their return journey the next day. They reached Cape Columbia on April 23, but ice prevented the *Roosevelt* from sailing south until July.

Dispute with Cook. Before Peary arrived back in the United States, he heard that Cook had claimed to have reached the pole from Greenland in 1908. Peary was outraged at Cook's challenge and claim of success. He doubted that Cook's experience and resources were adequate for a polar victory and quickly declared that Cook's claim was a fraud. Peary's supporters rallied to his cause and denounced Cook. Suspicions about Cook grew as he failed to submit adequate evidence to geographical societies. By 1910, Cook had been generally discredited, and Peary was recognized as winner of the polar race. Congress honored him with a promotion to rear admiral in 1911. After Peary died, he was buried at Arlington National Cemetery with full honors.

The controversy about the first journey to the North Pole continues. Over the years, a number of books have been written about Cook that portray him as the underdog of polar adventure who was wrongly treated by the public and the influential Peary Arctic Club. However, no further evidence has been found to support Cook's claim. Meanwhile, scientists and modern polar travelers have examined Peary's geographical evidence, and some of them have questioned his achievement. Most experts believe that Peary possibly gave himself the benefit of the doubt by claiming the pole, but that he, unlike Cook, was certainly close to it. William R. Hunt

See also Henson, Matthew Alexander; Cook, Frederick Albert.

Peasants' Revolt. See Wat Tyler's Rebellion.

Peasants' War refers to the rebellion of German peasants against their lords in 1524 and 1525. This was the greatest mass uprising in German history. The rebellion broke out late in 1524 at Stühlingen in the Black Forest and spread northward like wildfire. Soon all Germany, except Bavaria, felt its impact. The peasants stormed the castles and forced the nobles to grant their demands. Their flag, called the *Bundschuh,* was a black, white, and red cloth with a picture of a peasant's shoe.

The peasants had grumbled over the ever-increasing dues and services demanded by the princes for 50 years. The teachings of Martin Luther contributed to the peasants' rebellious feelings. The peasants hoped for and needed Luther's support of their uprising. However,

e rejected their charter of liberties. Luther urged the easants to lay down their arms. When the peasants did ot do what he suggested, Luther summoned the lords ı a pamphlet to strike down and stab the rebels "like ıad dogs." The nobility killed as many as 100,000 peasnts before the rebellion ended. The loss of so many eople eliminated the peasantry as a political factor for ıe next 300 years. William H. Maehl

'ease, *peez,* **Howard** (1894-1974), was an American uthor of stories for young people. He became best nown for his mystery and adventure stories, and sea ıles. His works include *Thunderbolt House* (1944), *Heart f Danger* (1946), *Captain of the Araby* (1953), and *Shipvreck* (1957).

Pease was born in Stockton, Calif. He was graduated om Stanford University, and later taught at the University of San Francisco. Jill P. May

'eat is partly decayed plant matter that has collected in wamps and marshes over long periods of time. It is enerally the first stage in the formation of coal. Dried eat varies from a light yellow-brown substance resembling tangled hay, to deeper layers of dark brown, comact material that looks like brown coal.

Peat forms in layers. The pale upper layers contain the emains of plants, herbs, and moss that died and rotted ı the shallow, acid water. They are compressed by the veight of water and other plants to form peat. The lower ıyers are about 90 per cent water, and look like mud.

Peat is found throughout the world. Canada and Finınd are among the countries with the largest deposits. efore its breakup, the Soviet Union was the largest eat producer. Ireland, Germany, and other countries roduced smaller amounts. The largest peat deposits in ıe United States are located in Minnesota. There are lso other peat *bogs* (marshes) in the United States, such s the Dismal Swamp in Virginia (see **Dismal Swamp**).

Most peat is harvested by machine. The machines ig, chop, and mix the peat and form it into blocks. The locks are then spread on the ground for drying. Some eat is still dug and stacked by hand.

Dried peat is used mainly as a fuel in places where oal and oil are scarce. In Ireland, for example, peat is a ıajor source of fuel to generate electricity. Peat is not sed as a fuel in the United States because of the high ost of drying it. Black peat is used as a fertilizer. Fluffy brown peat is used as a packing material, and as bedding for farm animals. Ray E. Ferrell, Jr.

See also **Coal** (How coal was formed); **Peat moss**; **Moss**; **Heath**.



Dan Budnik, Woodfin Camp, Inc.

eat bogs furnish much of the fuel used in Ireland. The peat is arvested in blocks and dried before it is burned.

Peat moss is a kind of moss from which peat is formed. Peat consists of partially decayed mosses and other plant matter that accumulate over long periods of time in marshy areas called *bogs* (see **Peat**). Peat mosses make up a *genus* (scientific group) called *Sphagnum* and are often referred to as *Sphagnum mosses.* About 200 species of peat mosses are found in bogs throughout Canada, Siberia, and northern Europe.

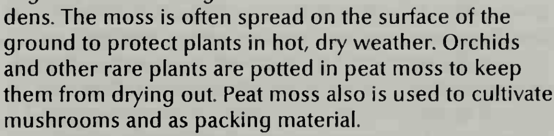
Peat mosses grow up to 20 inches (50 centimeters) high. They typically grow close together and form dense mats that vary in color from dark-brown and red to yellow-green. Peat mosses are soft and spongy and have no true roots. They absorb and hold water in large dead cells in the stems and leaves. These cells can store large quantities of water for long periods of time. Peat mosses also can make surrounding soil more acidic and thus delay the growth of fungi.



Runk/Schoenberger from Grant Heilman

Peat moss usually grows in swamps. It is soft and spongy, forming dense mats that vary in color.

Peat moss is often used in greenhouses and gardens. The moss is often spread on the surface of the ground to protect plants in hot, dry weather. Orchids and other rare plants are potted in peat moss to keep them from drying out. Peat moss also is used to cultivate mushrooms and as packing material.



Scientific classification. Peat mosses belong to the family Sphagnaceae. They make up the genus *Sphagnum.*

Dale H. Vitt

See also **Moss** (picture: Mosses).

Peattie, *PEET ih,* **Donald Culross,** *kuhl RAWS* (1898-1964), an American author and botanist, became well known for his popular books of natural history. He wrote with a lyrical beauty about nature.

Peattie's works include *Singing in the Wilderness* (1935), *Green Laurels* (1936), and *Journey into America* (1943). *The Road of a Naturalist* (1941) is his autobiography. He also wrote scientific works and books for children. He was born in Chicago. He attended the University of Chicago and Harvard University. Keith R. Benson

Pecan, *pih KAHN* or *PEE kan,* a tree native to North America, is valuable for its fruit, the pecan nut. The pecan is a type of hickory. It grows naturally in the Mississippi Valley region from Iowa southward, and in the river valleys of Oklahoma, Texas, and northern Mexico. But pecan orchards are planted throughout the Southern United States as far north as Virginia, and in California. In addition, a small number of pecans are grown commercially in Australia, South Africa, and the Middle East.

Pecan raising is an important U.S. industry, especially in the South. Pecan orchards produce about 250 mil-



WORLD BOOK illustration by Kate Lloyd-Jones, Linden Artists Ltd.

The pecan nut has a smooth shell, *bottom left.* Next to it is the meat of the nut. A husk encloses each nut, *far right.*

lion pounds (113 million kilograms) of nuts in an average year. About four-fifths of them are marketed as shelled nuts. Some pecan trees produce up to 500 pounds (230 kilograms) of nuts each year. But the trees do not bear nuts until they are about five or six years old. For another five years, they do not bear enough nuts to be profitable. Only after the trees are about 20 years old does the owner receive full return on the investment. Although the pecan is chiefly grown for its fruit, its wood is valuable for flooring, furniture, and paneling.

Pecan trees may grow 180 feet (55 meters) high. Their trunks are sometimes 4 to 6 feet (1.2 to 1.8 meters) in diameter near the ground, but most trees are smaller. The light brown or gray bark of pecan trees is deeply furrowed. The leaves are 12 to 20 inches (30 to 51 centimeters) long. They are made up of from 9 to 17 lance-shaped leaflets.

Pecan orchard trees are usually grown by grafting branch buds from trees that bear fine quality nuts on seedling stocks. In addition, pecan growers may manage and harvest nuts from groves of wild pecan trees. Pecan flowers are pollinated by the wind. However, most varieties of pecan trees are not pollinated by their own kind. For this reason, pecan orchards usually contain several different kinds of pecan trees. The thin-shelled pecans, which are called *papershell,* are a popular type because their shells can be cracked between the fingers.

Growers harvest the pecans after they fall to the ground. The nuts may fall naturally or be shaken off the trees using mechanical shakers. They are taken to processing centers where they are cleaned, graded, and packaged. The shelled nuts are cracked and most often sorted by machines. Richard A. Jaynes

Scientific classification. Pecans belong to the walnut family, Juglandaceae. They are *Carya illinoensis.*

See also Texas (picture: State tree); Tree (Familiar broadleaf and needleleaf trees [picture]).

Peccary, *PEHK uhr ee,* is a hoofed animal that lives in forests and desert scrublands. It is distantly related to the wild hog. There are three living species of peccaries: (1) the *collared peccary,* or *javelina;* (2) the *white-lipped peccary;* and (3) the *tagua,* or *Chacoan peccary.* The collared peccary lives in many sections of South America and as far north as the Southwestern United States. The white-lipped peccary is found in an area from central Mexico south to Paraguay. The tagua lives in the Gran Chaco region of Paraguay, Argentina, and Bolivia. Scientists discovered the tagua in 1975. They had previously thought that this species had become extinct more than 10,000 years ago.

Peccaries look much like slender hogs. The collared peccary stands about 21 inches (53 centimeters) high at the shoulder. It has a coarse, grizzled, blackish-gray coat with a gray collar. The white-lipped peccary is larger and darker. It is marked by white patches that extend from the mouth along the side of its face. The tagua, the largest living species, stands about 30 inches (76 centimeters) high at the shoulder. It has a coat of brownish-gray bristles with a gray collar. Peccaries have a large gland on their arched back, about 8 inches (20 centimeters) in front of the tail. When the animal becomes excited, the gland gives off a small amount of *musk,* a substance with a strong odor. For this reason, peccaries are sometimes called *musk hogs.*

The mother peccary usually gives birth to twins, which are about the size of rabbits. The young have reddish coats with a black stripe down their backs.

Peccaries feed chiefly on roots, but they sometimes prey on small animals. They travel in bands that may have up to several hundred individuals. They are shy, timid animals that flee from danger whenever possible. But if cornered, they fight viciously with their sharp teeth. Their most common natural enemy is the jaguar. Pigskin jackets and gloves are made from the thin, tough hides of peccaries. The skin can be recognized because the hair roots leave a pattern of three holes in evenly distributed groups. Jerry F. Downhower

Scientific classification. Peccaries make up the family Tayassuidae. The scientific name for the collared peccary is *Tayassu tajacu;* the white-lipped peccary is *Tayassu peccari;* and the tagua is *Catagonus wagneri.*

Peck is a unit of dry measure that is equal to 8 quarts or a quarter of a bushel (0.0088 cubic meter). Dry foods, such as potatoes and beans, are measured by the peck.

Peckham, Rufus W. (1838-1909), was an associate justice of the Supreme Court of the United States. Peckham believed in as little government interference with business as possible, and opposed many reform and welfare measures. He was noted for his opinion in the 1905 *Lochner v. New York* case, in which he voted with majority of the court to overrule a law that limited bakers to a 60-hour workweek (see **Lochner v. New York**).

Peckham was born in Albany, New York. He began to practice law in New York in 1857. He was elected to the New York Supreme Court in 1883. Later, in 1886, Peckham was elected to the State Court of Appeals. President Grover Cleveland named him to the Supreme Court of the United States in 1895, and he served from 1896 until his death in 1909. Stanley I. Kutler

Pecos Bill, *PAY kuhs* or *PAY kohs,* is a cowboy hero American folklore and popular tradition. He was the legendary inventor of roping, branding, and other cowboy skills. He also invented the six-shooter and train robbery and taught broncos how to buck.

According to legend, Pecos Bill was born in eastern Texas during the 1830's. He used a bowie knife as a



Bob and Clara Calhoun, Bruce Coleman Ltd.

The collared peccary has a coarse, blackish-gray coat. The animal has a lighter ring around its neck that resembles a collar.

eething ring and played with wild animals. During a trip vest, Bill fell out of the family wagon near the Pecos River. He became lost and was raised by coyotes.

To win a bet, Pecos Bill once rode an Oklahoma cyclone without a saddle. The cyclone could not throw him and finally "rained out" from under him in Arizona. The rain fell so heavily that it created the Grand Canyon. Bill crashed in California, and the force of his fall created Death Valley. There are several versions of Bill's death. In one, he laughed to death after a man from Boston asked him silly questions about the West.

The legend of Pecos Bill developed from a magazine article written in 1923 by Edward O'Reilly, an American journalist. O'Reilly patterned Bill after Paul Bunyan and other legendary frontier heroes. Ellen J. Stekert

Pecos National Historical Park, *PAY kuhs* or *PAY kohs,* in north-central New Mexico, contains ruins of the ancient *pueblo* (village) of Pecos. It also includes the remains of two Spanish missions built in the 1600's and 1700's. The Pecos ruins became a landmark on the Santa Fe Trail. The site became a national monument in 1965 and was reclassified as a national historical park in 1990. For the area of the park, see **National Park System** (table: National historical parks).

Critically reviewed by the National Park Service

Pecos River, *PAY kuhs* or *PAY kohs,* is the largest branch of the Rio Grande. The Pecos starts near Santa Fe, New Mexico, in the southern Sangre de Cristo Mountains. For most of its 800-mile (1,300-kilometer) course, the Pecos flows southeast. It runs beside the western palisade of Llano Estacado, a great plateau in New Mexico and Texas. It flows into the Rio Grande in Texas, near the town of Del Rio. It drains over 33,000 square miles (85,500 square kilometers). Reservoirs built along the river for irrigation include Lakes Avalon, McMillan, Red Bluff, and Sumner. For location, see **Texas** (physical map). Daniel D. Arreola

Pécs, *paych* (pop. 172,177), is an industrial center in the coal- and uranium-mining region of southwest Hungary. For location, see **Hungary** (political map). Pécs stands on the site of an ancient Roman settlement. Hungary's first university was founded at Pécs in 1367. Other landmarks include a cathedral built in the 1000's and several structures built by the Turks, who occupied the city during the 1500's and 1600's. Thomas Sakmyster

Pectin, *PEHK tuhn,* or *pectinic acid,* is a substance found in the cell walls of many fruits and some vegetables. Pectin binds cells to one another and provides firmness in the fruit or vegetable. It is used as a gelling agent in many processed foods and as a thickener in such foods as jelly, jam, preserves, and relish. Pectin provides dietary fiber but has no other nutritional value. It belongs to the carbohydrate group of foodstuffs, which includes starches and sugars.

The amount and type of pectin in a fruit depends on the species. Some fruits, including apples, currants, grapefruit, oranges, and plums, contain a large amount of the kind of pectin that causes gelling. When such fruits are cooked to make jelly or jam, the pectin forms a network of fibers that thicken the fruit juices. The pectin in other fruits, such as apricots, cherries, pineapples, and strawberries, does not cause these fruits to gel when they are cooked. However, commercial pectin can be added to thicken the mixture. Commercial pectin, available as a liquid or powder, is made from the rinds of apples and citrus fruits, especially lemons and oranges. Wilfred F. Wardowski

See also **Jelly and jam.**

Pediatrics is the branch of medicine concerned with the health of children. It deals with all aspects of a child's physical and emotional development and well-being, including the treatment of diseases and disabilities. It frequently involves preventive health care. Doctors who practice pediatrics are called *pediatricians.* These doctors provide care for children from birth through adolescence.

Pediatrics developed as a branch of medicine because many health problems occur chiefly or only in children. For example, chickenpox affects far more children than adults. Children are physically and psychologically different from adults, and so doctors must treat them differently. Children also grow rapidly and thus they change more quickly than do adults.

After graduating from medical school, a doctor who wishes to become a pediatrician must complete at least three years of special training in health care for children. The doctor then can become a certified pediatrician by passing an examination given by a pediatrics specialty board. Many pediatricians take two to three years of additional training in a particular area of pediatrics. For example, they may specialize in blood diseases or cancer; in certain organ systems, including the heart, kidneys,

or lungs; or in patients in specific age groups, such as newborns or adolescents. Such subspecialists act as consultants to other doctors and often conduct research on growth and development or on the treatment of disease. Gerald B. Merenstein

See also **Neonatology**.

Pedicab, *PEHD uh KAB,* is a type of three-wheeled vehicle used as a taxicab. It is similar to a bicycle, but it has two rear wheels instead of one. It also has a passenger carriage that sits above the rear wheels. The carriage is often covered and partially enclosed. The driver sits on a bicycle seat and pushes pedals that turn the rear wheels. The driver guides the pedicab with bicycle handle bars.



E. R. Degginger

The pedicab was once widely used as a taxicab in many cities in Asia. Today, pedicabs are popular with tourists.

Pedicabs replaced *jinrikishas,* the hand-pulled carts once widely used as taxicabs in China, Japan, and other Asian countries (see **Jinrikisha**). Autos have replaced pedicabs in the major cities of Asia. Robert C. Post

Pedigree, *PEHD uh gree,* is a record of the ancestors of an animal or plant. To be most useful, a pedigree should record *traits* (characteristics) of the ancestors as well as their names and their birth and death dates. Breeders use pedigree information to predict such traits as size, strength, and color of hair in offspring. This information is considered so important in the improvement of livestock that breeders' associations have been formed to record the pedigrees of animals used for breeding. These animals are then said to be *registered.*

Pedigrees of plants are also helpful. But they are usually made for groups rather than individual plants. Hybrid corn breeders are careful to select and preserve known *pedigree lines* (families) of corn. Records of human ancestry are sometimes called *family trees.* The study of some family pedigrees enables scientists to predict the inheritance of certain diseases and physical defects. See **Genealogy**. George B. Johnson

See also **Breeding; Genetics; Heredity**.

Pedometer, *pih DAHM uh tuhr,* is a small instrument that measures the distance a person walks. The pedometer may be either mechanical or electronic. It is usually worn on the belt. With each step, the motion of the body causes a small lever to move. This lever records the number of steps taken. To find out how far you have walked, you must find the average length of your step and multiply it by the number of steps recorded. In some pedometers, a mechanism accounts for the length of the step, and measures the distance walked.

Thomas T. Liao

Pedro I, *PAY droh* or *PAY throo* (1798-1834), was the first emperor of independent Brazil. He ruled from 1822 to 1831.

Pedro was born on Oct. 12, 1798, in Lisbon, Portugal. He was the son of Prince John (later King John VI) of Portugal. In 1807, the Portuguese royal family fled to Brazil, a colony of Portugal, to escape capture by invading French troops. In 1821, John returned to Lisbon. He left Pedro to rule Brazil as prince regent.

Pedro was strongly influenced by a group of Brazilian-born counselors who favored independence for Brazil. On Sept. 7, 1822, he declared Brazil's independence. He was crowned emperor a few months later.

In 1826, John VI died, and Pedro became King Pedro IV of Portugal. Later that year, Pedro gave up the Portuguese throne in favor of his daughter, who eventually ruled Portugal as Maria II. Strong-willed and undemocratic, Pedro became increasingly unpopular in Brazil. In 1831, he gave up the throne in favor of his son Pedro II and returned to Portugal. Robert M. Levine

Pedro II, *PAY droh* or *PAY throo* (1825-1891), was emperor of Brazil from 1831 to 1889. During his rule, Brazil experienced modernization and economic progress, as well as the abolition of slavery.

Pedro was born on Dec. 2, 1825, in Rio de Janeiro. His grandfather was King John VI of Portugal. His father, Pedro I, became the first emperor of independent Brazil in 1822. Before then, Brazil had been a colony of Portugal.

In 1831, Pedro I gave up the throne, and Pedro II became emperor. Elected officials headed the government until 1840, when Pedro was declared old enough to rule on his own. Pedro gained respect as a moderate and humane ruler. Under him, Brazil helped overthrow Argentina dictator Juan Manuel de Rosas in 1852. In 1867, Pedro's government opened the Amazon River to world commerce. Between 1871 and 1888, his government passed a series of acts abolishing slavery in Brazil. This action cost Pedro the support of Brazil's great landowners. In 1889, the army forced Pedro to give up the throne and formed a republic. Robert M. Levine

See also **Brazil** (Independence; The reign of Pedro II).

Peel, Sir Robert (1788-1850), was a famous British statesman. He founded the London police force in 1829. The police have been called *bobbies,* after Peel's nickname, ever since. Peel also served as Britain's prime minister in 1834 and 1835 and from 1841 to 1846.

Peel was born on Feb. 5, 1788, near Bury, the son of a wealthy textile manufacturer. He attended Harrow School and Christ Church College of Oxford University, where he earned honors in classics and mathematics. When Peel was 21 years old, he made his brilliant first speech in the House of Commons. This speech led to his appointment as undersecretary for war and the colonies.



Chicago Historical Socie

Sir Robert Peel

From 1812 to 1818, as chief secretary, Peel ruled Ire-ınd with a strong hand. He maintained order by es-ıblishing an Irish police force, whose members were ommonly called *Peelers.* His strong opposition to mancipation of Roman Catholics helped keep Catholics ·om holding seats in Parliament until 1829. Such per-onal bitterness over the Catholic question grew up be-ween Peel and Daniel O'Connell, the Irish leader, that ıe two nearly dueled.

In 1819, Peel headed a commission to study British urrency. He recommended important reforms that ave the United Kingdom a sounder currency system. le became home secretary in 1822, but resigned in 827 when George Canning became prime minister, be-ause they disagreed on the Roman Catholic question. ı 1828, Peel returned to office under the Duke of Vellington. Peel organized the London police force in 829 to aid in enforcing the criminal code, which he elped revise and reform. In the same year, the political ituation caused him to change his mind on the Roman Catholic question. He helped prepare and pass the Catholic Emancipation Act, which allowed Catholics to old seats in Parliament and most government offices.

Starts Conservative Party. Peel went out of office gain in 1830 when the Duke of Wellington's ministry ell. He opposed the Reform Bill, designed to give the ote to more people and better representation to new ndustrial towns. As a member of the minority opposi-on in the House of Commons, he formed the Conserva-ve Party from the old Tory Party. Although the party vas conservative in regard to the British constitution, 'eel labored to make the party concerned with the na-on's welfare. As leader of the Conservative Party, Peel erved as prime minister for a short time in 1834 and 835. He was also prime minister from 1841 to 1846.

Prime minister. Under Peel's leadership, certain im-ortant tax reforms were made. Circumstances caused im to change his mind in regard to the Corn Laws, vhich worked to the advantage of landowners by keep-ng food prices high. In 1842, Peel caused the laws to be mended so that prices would be lower. Then a famine ı Ireland, which also resulted in great hardship in Eng-ınd, led him to favor immediate repeal of the Corn aws. Peel admitted that he could no longer answer the rguments of Richard Cobden of the Anti-Corn Law eague, and he argued for free trade (see **Corn Laws**). oon after the Corn Laws were repealed in 1846, Peel ɜft office. Richard W. Davis

'eeper. See **Tree frog.**

'eerce, Jan (1904-1984), became one of the most suc-essful American opera and concert tenors of his day. lis faultless musicianship won praise from Arturo oscanini and other leading conductors. Peerce was the ɜnor in several of the famous Toscanini-NBC opera adio broadcasts. The broadcasts were later transferred ɔ commercial recordings. Peerce's lyrical voice re-ained its power even when he was more than 60 years ld.

Peerce was born in New York City. His real name was acob Pincus Perelmuth. Peerce played the violin in ance orchestras before he became a tenor at Radio ity in 1933. He made his operatic debut in 1938 in hiladelphia as the duke in Giuseppe Verdi's *Rigoletto.* eerce appeared in a New York recital in 1939 and made his debut with the Metropolitan Opera in 1941 as Alfre-do in Verdi's *La Traviata.* Charles H. Webb

Peewit. See **Lapwing.**

Pegasus, *PEHG uh suhs,* was an immortal winged horse in Greek mythology. He was the offspring of Medusa, a monstrous, snake-haired woman, and Posei-don, god of horses and of the sea. The hero Perseus slew Medusa by cutting off her head. Pegasus sprang full-grown either from her head or neck, or from the blood from her neck.

The hero Bellerophon wanted to tame Pegasus. A prophet advised him to sleep on the altar of the god-dess Athena. There, Bellerophon dreamed that the god-dess gave him a golden bridle and ordered him to make a sacrifice to Poseidon. When he awoke, Bellerophon



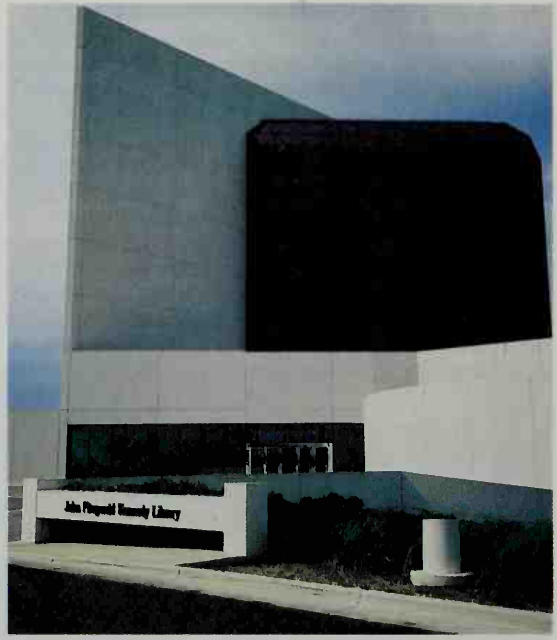
Detail from painting by Andrea Mantegna (late 1400's); The Louvre, Paris (SCALA/Art Resource)

Pegasus, the winged horse, appears in Greek mythology. It is shown here with Mercury, the messenger of the gods.

found a bridle on the altar. He sacrificed a bull to Posei-don and later came upon Pegasus at a spring, waiting to be bridled.

Bellerophon rode Pegasus on many adventures. Their most famous feat was destroying the fire-breathing Chimera (see **Chimera**). Bellerophon attempted to ride Pegasus up to Mount Olympus, the heavenly home of the gods. Zeus, king of the gods, was angered by the mortal's presumption in attempting to reach the heav-ens. Zeus sent a gadfly to sting Pegasus. The horse bucked, throwing Bellerophon down to earth and per-manently crippling him. Pegasus arrived on Olympus without a rider. The horse remained there, carrying Zeus's lightning and thunderbolts. Nancy Felson

See also **Medusa.**



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Pei's John F. Kennedy Library in Boston is built of white concrete and glass. The nine-story structure emphasizes the broad, irregular geometric shapes that are typical of Pei's designs.

Pei, *pay,* **I. M.** (1917-), is an American architect noted for his creative urban designs. These designs include skyscrapers, housing projects, museums, and academic and government buildings. Pei's buildings are characterized by broad irregular geometric shapes and large open interiors.

Ieoh Ming Pei was born in Guangzhou (also called Canton), China, and came to the United States in 1935 to study architecture. He became a U.S. citizen in 1954. Pei's early works show the influence of the modern German architects Walter Gropius and Ludwig Mies van der Rohe. These works include the Mile High Center (1955) in Denver, Colorado, and the Society Hill housing project (1964) in Philadelphia.

In the late 1960's, Pei began to develop a more personal style using prism shapes. His later projects include the National Center for Atmospheric Research (1967) in Boulder, Colorado; the Everson Museum of Art (1968) in Syracuse, New York; the John Hancock Building (1973) in Boston; the East Building (1978) of the National Gallery of Art in Washington, D.C.; and the John F. Kennedy Library (1979) in Boston. In 1989, Pei completed the glass pyramid that serves as the entrance to the Louvre museum in Paris. His Rock and Roll Hall of Fame and Museum in Cleveland opened in 1995. Pei also designed the Miho Museum (1997) near Kyoto, Japan. Nicholas Adams

See also **National Gallery of Art** (picture).

Peiping. See **Beijing.**

Peipus, Lake. See **Lake Peipus.**

Peirce, *purs,* **Charles Sanders** (1839-1914), was an American philosopher. He helped lead a philosophical movement called *pragmatism.* Peirce, who was probably the foremost logician of his time, pioneered in the development of mathematical logic. In addition, Peirce helped develop *semiotics,* the study of how human beings use various signs and symbols, including words.

Peirce discussed the basic ideas of his pragmatism in an essay called "How to Make Our Ideas Clear" (1878). To understand an idea, he declared, we need to consider the behavior of objects to which the idea refers. For example, if we say that a diamond is "hard," we should want to know what this idea means. Therefore, we should find out what a diamond can do—such as scratch a piece of glass without being scratched itself. We understand what we mean by a diamond if we know what it does do, could do, and might do under various circumstances. The meaning of an object, according to Peirce, includes how we are likely to behave in its presence.

Like other pragmatists, Peirce wanted to connect thought and action. He believed that our thoughts should produce beliefs upon which we can act confidently. If we are in doubt, we hesitate to act. Doubt forces us to inquire into things until we have a belief. If we are not able to clear up our doubts with further inquiry, we must act on the belief most likely to be true.

Peirce was born in Cambridge, Massachusetts. His father, the famous mathematician Benjamin Peirce, introduced him to the study of science and philosophy. Peirce graduated from Harvard University in 1859 and did scientific work for the United States Coast Survey from 1861 to 1891. These scientific studies stimulated his interest in philosophy. During his career, Charles Peirce also expressed original ideas about evolution, the role of chance in the universe, the human mind, and the reality of God.

Peirce did not present his philosophy in any organized fashion, and so he received little recognition during his lifetime. Years after his death, however, several philosophers published Peirce's works in eight volumes called *The Collected Papers of Charles Sanders Peirce.*

John E. Smith

See also **Pragmatism.**

Peking. See **Beijing.**

Peking fossils, *pee KIHNG,* are the remains of a type of prehistoric human being who lived between about 600,000 and 400,000 years ago in what is now northern China. Scientists named these people *Sinanthropus pekinensis,* which means *Chinese person of Peking.* The Peking people belong to a species of human beings called *Homo erectus* (erect human being).

In the 1920's, Davidson Black, a Canadian anatomy professor, identified fossils found near Beijing (also spelled Peking), China, as remains of prehistoric human beings. Since then, scientists have found the partial remains of more than 30 of these prehistoric people, along with more than 100,000 stone tools and countless animal bones, mainly those of deer.

The fossils show that the Peking people stood about 5 feet 1 inch (155 centimeters) tall and had heavy bones. These people apparently had big browridges, powerful jaws, large teeth, and a brain smaller than that of modern people.

In 1941, most of the fossils disappeared while being shipped out of China. In 1963 and 1964, scientists found similar fossils at Lantian (Lan-t'ien), about 600 miles (970 kilometers) southwest of Beijing. Karl W. Butzer

Pekingese, *PEE kihng EEZ,* is a small dog with long hair, a broad flat face, and a tail that curls over its back.

he Pekingese has short legs, a long body, and a large ead with long-fringed ears. Its front legs are bowed, nd its tail is plumed. When the Pekingese trots, it sways om side to side. It may be almost any color, but is usu-ly tan or brown with light shadings. It weighs from 6 to) pounds (2.7 to 4.5 kilograms). One kind, the *sleeve ekingese,* was so named because ladies of the Chinese ourt carried the dogs in their balloonlike sleeves.

The Pekingese was the royal dog of China, and at one me only people of royal blood could own the dog. It as been raised in China since the 700's, but the rest of e world did not know of the dog until 1860, when the ritish Army seized Beijing (also spelled Peking) and Ad-iiral Lord Hayes took two Pekingese to England. The ekingese can make an intelligent, loyal pet.

Critically reviewed by the American Kennel Club

See also **Dog** (picture: Toy dogs); **Shih Tzu.**

'elé, *peh LAY* (1940-), a Brazilian athlete, won fame s the greatest soccer player of his time and the most ecognized athlete in world sports. A forward, Pelé elec-ified crowds with his daring dribbling, perfect passing, nd accurate shooting. He holds every major scoring ecord in Brazil, and scored 1,281 goals in 1,363 games uring his professional career. Pelé is the only profes-ional soccer player to score 1,000 goals in a career.

Pelé was born on Oct. 23, 1940, in Três Coracaoes, razil. His real name is Edson Arantes do Nascimento. elé joined the Santos (Brazil) Football Club in 1956 and d it to world club titles in 1962 and 1963. He is the only occer player to have played on three world champion-hip teams, leading the Brazilian national team to World up titles in 1958, 1962, and 1970. Pelé retired as a player 1 1974 but returned to competition in 1975 with the lew York Cosmos of the North American Soccer eague (N.A.S.L.). Pelé retired again after leading the Cos-los to the N.A.S.L. championship in 1977. John E. Polis

'elée, Mount. See Mount Pelée.

'elican, *PEHL uh kuhn,* is a large bird that lives near vater. Pelicans have a long, straight bill with a flexible ouch made of skin on the underside. They use the ouch to catch fish, their chief food. Pelicans also eat ther animals, such as salamanders and frog tadpoles. he birds have webbed feet and can swim well. They lso are skilled fliers, but they are clumsy on land.

Kinds. There are seven species of pelicans. Five have vhite feathers with some black on the wings. Of the re-iaining two kinds, one is gray and white, and the other brown. The brown species, or *brown pelican,* inhabits oasts of North and South America. The six other spe-ies live along rivers and near freshwater lakes in North merica, Europe, Africa, Asia, and Australia. They in-lude the *American white pelican* and *Australian pelican.*

The American white pelican weighs about 16 pounds 7 kilograms) and is about 5 feet (1.5 meters) long. It has a vingspread of up to 10 feet (3 meters). The bird nests in vestern and central North America. It migrates in the fall s far south as Mexico and Central America.

The Australian pelican, the largest pelican species, rows to about 6 feet (1.8 meters) long and weighs up to 4 pounds (15 kilograms). Its wingspread reaches over 8 eet (2.4 meters). This pelican lives throughout Australia.

The brown pelican lives as far north as North Carolina nd British Columbia. It ranks as the smallest species of elican. It measures about 4 feet (1.2 meters) long and has a wingspread of about 7 feet (2 meters).

Habits. American white pelicans often fish in groups. They swim along the top of the water in a line, driving the fish ahead of them. After the fish have been chased into shallow water, the pelicans scoop up the catch with their pouches. The brown pelican flies until it spots a fish near the surface of the water. Then it dives into the water to catch the fish.

Pelicans are almost always seen in flocks. While flying, American white pelicans may gather in flocks of up to 1,000 birds. These birds may soar upward in tight circles on a rising current of hot air called a *thermal.*

Pelicans nest in large *colonies* (groups). Some peli-cans nest in trees. They build their nests out of twigs and other plant materials. Other pelicans nest in small hollows on the ground, usually on islands. Female peli-cans lay two or three chalky-white eggs, which hatch in about a month. Pelicans are born without feathers. They cannot fly until they are about 10 to 12 weeks old.

Pelicans and people. Housing and commercial de-velopments have endangered pelicans in many parts of the world. Such developments often pollute the peli-cans' feeding grounds and destroy their nesting sites. Two of the most endangered pelican species, the *Dal-matian pelican* of Europe and Asia and the *spot-billed pelican* of south and southeast Asia, have seen much of their natural habitat destroyed by human development.

People have also reduced pelican populations be-cause they perceived the birds as a threat. For example, American white pelicans were killed because fishermen believed the birds ate game fish. Studies of white peli-cans, however, have proven this belief to be untrue.

Over the years, people have worked to conserve peli-cans in many ways. In 1903, United States President Theodore Roosevelt set up the first U.S. national wildlife refuge—Pelican Island, in Florida—to protect nesting



Wardene Weisser, Berg & Associates

Brown pelicans inhabit coastal areas of North and South Amer-ica. Adults grow to about 4 feet (1.2 meters) in length.

sites of brown pelicans. Today, many nations have laws protecting pelicans and their habitats. Fritz L. Knopf

Scientific classification. Pelicans belong to the family Pelecanidae. The scientific name of the American white pelican is *Pelecanus erythrorhynchos.* The brown pelican is *P. occidentalis,* the Australian pelican is *P. conspicillatus,* the Dalmatian pelican is *P. crispus,* and the spot-billed pelican is *P. philippensis.*

See also **Bird** (picture: Birds of the seacoasts).

Pelican flower is a vine of tropical North America and South America. The vine has pointed, heart-shaped leaves. The flower consists of a large greenish-yellow tube that starts down and bends up, forming a U. At the tube's end, the edges flare out in the shape of a shield. The shield may be 12 inches (30 centimeters) wide. It has purple veins and spots and usually ends in a "tail" that may extend 3 feet (91 centimeters). Theodore R. Dudley

Scientific classification. The pelican flower belongs to the birthwort family, Aristolochiaceae. It is *Aristolochia grandiflora.*

Pellagra, *puh LAG ruh* or *puh LAY gruh,* is a disease caused by a lack of niacin and other B-complex vitamins (see **Vitamin** [Vitamin B complex]). Corn is a poor source of niacin, and many people who eat corn as the main part of their diets develop pellagra. In the early 1900's, American physician Joseph Goldberger proved that pellagra was associated with diet (see **Goldberger, Joseph**).

Today, pellagra occurs chiefly in developing nations where corn and corn products are the major food source. It also may affect people who do not have a proper diet, especially the poor and people dependent on alcohol or drugs.

Early symptoms of pellagra include weakness, lack of appetite, diarrhea, and indigestion. *Dermatitis* (skin inflammation) develops especially on body parts exposed to sunlight, heat, friction, or other irritants. The tongue becomes swollen and sore, and *lesions* (skin eruptions) develop in and around the mouth. Later symptoms include anxiety, headaches, irritability, and sleeplessness. In extreme cases, severe psychosis may develop.

Pellagra is treated by changing the diet so that it includes a sufficient amount of protein-rich foods, such as meat, fish, eggs, and milk and milk products. These foods are good sources of niacin or of the amino acid *tryptophan,* which the body converts into niacin. In some cases, physicians prescribe niacin tablets for patients with pellagra. Mary Frances Picciano

Pelopidas, *puh LAHP ih duhs* (? -364 B.C.), was a general and statesman in ancient Thebes. In 382 B.C., the Spartans seized Thebes, and Pelopidas fled. Returning in 379 B.C., he drove the Spartans out. Aided by Epaminondas, another general, he trained the Thebans in military discipline and strategy. Pelopidas led a group of 300 soldiers called the *Sacred Band.* He also helped reorganize the Boeotian and Thessalian leagues, two former groups of Greek cities that had become inactive. Pelopidas and Epaminondas led the Boeotian League to victory over Sparta in the Battle of Leuctra in 371 B.C., making Thebes the most powerful state in Greece. In 364 B.C., Pelopidas was killed in battle. Epaminondas died in war two years later, and Thebes's supremacy collapsed. Linda J. Piper

Peloponnesian War, *PEHL uh puh NEE shuhn,* was fought by the ancient Greek city-states of Athens and Sparta from 431 to 404 B.C. According to Thucydides, a Greek historian who lived during the war, the Peloponnesian League, consisting of Sparta and its allies, attacked the Athenian empire because it feared the growing power of Athens.

The war was divided into three parts: (1) *The Archidamian War* (431-421 B.C.) was named for Archidamus, the Spartan king who led annual attacks on Athens. He hoped to force a surrender, but the Athenian navy successfully defended the city, which was also protected by walls. (2) *The Peace of Nicias* (421-413 B.C.) was arranged by Nicias, an Athenian politician. It was broken when Athenian commander Alcibiades persuaded Athens to attack the Peloponnesian League in 418 B.C. and Sicily in 415 B.C. Both attacks failed. (3) *The Decelean* or *Ionian War* (413-404 B.C.) ended in victory for Sparta. Sparta gained Persia's support, helped subjects of Athens revolt, and forced Athens to surrender. Peter Krentz

See also **Alcibiades; Athens; Greece, Ancient** (The rivalry between Athens and Sparta); **Pericles; Sparta.**

Peloponnesus, *PEHL uh puh NEE suhs,* is the ancient name of the southern peninsula of Greece. It was linked to the mainland by the Isthmus of Corinth and was sometimes called the "island of Pelops." In ancient times the Peloponnesus consisted of six divisions: Achaea, Arcadia, Argolis, Elis, Laconia, and Messenia. In medieval times it was known as Morea. Peter Krentz

See also **Achaeans; Arcadia; Greece** (The Peloponnesus; Tourism); **Greece, Ancient** (map); **Messenia.**

Pelosi, Nancy (1940-), became the *whip* (assistant leader) of the Democrats in the United States House of Representatives in 2002. The post is the highest congressional office ever held by a woman. Pelosi has been a congresswoman from California since 1987, representing San Francisco.

As a member of the House, Pelosi became known for her liberal views. She has opposed closer trade relations with China because she disapproves of that country's human rights record. She also played a role in increasing government funding for AIDS research.


Office of the Democratic Wh
Nancy Pelosi

Pelosi was born Nancy Patricia D'Alesandro in Baltimore. Her father, Thomas D'Alesandro, Jr., was a Democratic member of the U.S. House of Representatives at the time of her birth and later served as mayor of Baltimore from 1947 to 1959. Her brother Thomas also served as Baltimore mayor, from 1967 to 1971.

Nancy D'Alesandro graduated from Trinity College in Washington, D.C., in 1962 with a bachelor's degree in history and political science. In 1963, she married Paul F. Pelosi, who became a successful investor. She served as chair of the California Democratic Party from 1981 to 1983. Jeremy D. Mayer

Pelvic inflammatory disease, often referred to as *PID,* is an infection of the female reproductive system. It affects a woman's uterus and fallopian tubes, both of which are located in the pelvic cavity. PID is caused by several bacteria, particularly the ones that cause gonorrhea and chlamydia. In most cases, the bacteria enter a

woman's body during sexual intercourse with an infected male. If untreated, the disease can lead to infertility and, in rare cases, death.

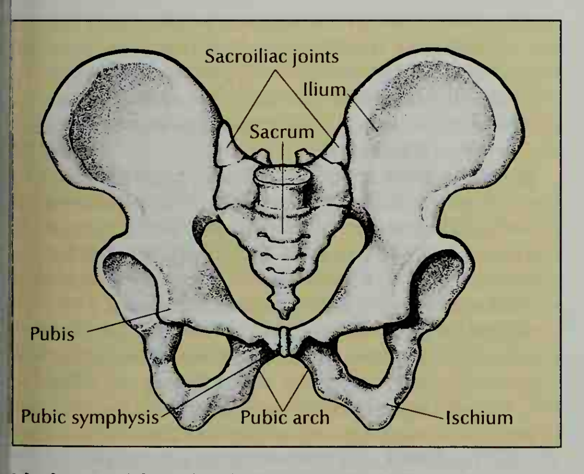
Many patients with acute PID experience symptoms during or shortly after their menstrual period. Symptoms include lower abdominal pain, vaginal discharge, fever, and nausea. Patients notice tenderness of the uterus, fallopian tubes, and ovaries upon examination by a physician. In severe cases, patients may have an *abscess* (collection of pus) in the infected area. PID also is a primary risk factor for *ectopic,* or *tubal, pregnancy,* a potentially fatal condition in which a fertilized egg starts developing in a fallopian tube instead of in the uterus.

Women with mild cases of PID can be treated with antibiotics as outpatients. Those with severe PID should be hospitalized and given antibiotics intravenously. Patients with an abscess may need surgery. Patrick Duff

See also **Chlamydia; Gonorrhea.**

Pelvis is the bony structure that supports the lower abdomen. It surrounds the urinary bladder, the last portion of the large intestine, and, in women, the reproductive organs. A female's pelvis is flatter and broader than a male's, and it has a larger central cavity.

The spinal column joins the pelvis at the *sacroiliac joints.* The *femurs* (thigh bones) join the lower part of the pelvis in large ball-and-socket hip joints that allow the legs to move in many directions. Many large muscle masses lead from the pelvis to the femurs.



The bones of the pelvis form a basinlike structure.

Two big, symmetrical hipbones form the pelvis. These bones join in front to form the *pubic symphysis.* In back, they form a strong union with the *sacrum* (five backbones joined to form a single bone). Each hipbone in an adult appears to be one solid bone. But it is formed by three bones, the *ilium, ischium,* and *pubis,* that unite as the body matures. The ilium is the broad, flat bone you feel when you rest your hand on the hip. When you sit down, much of your weight rests on the ischium. The pubis bones form two arches in front that join at the symphysis. Madison B. Cole, Jr.

Pembroke Welsh corgi, *PEHM bruk WEHLSH KAWR gee,* is a breed of dog that originated in the area of Pembroke, Wales, during the early 1100's. The Celtic people used these dogs to drive cattle and for other farm work. Pembroke Welsh corgis are the smallest of the group of breeds called *herding dogs.* They stand from 10 to 12 inches (25 to 30 centimeters) high and weigh from 18 to 30 pounds (8 to 14 kilograms). Pembrokes have thick coats that protect them from all kinds of weather. The dogs are generally yellowish- or reddish-brown and may have white patches on the head, neck, chest, and legs. Some Pembrokes have black and tan coats. Pembrokes are considered highly intelligent, and they make affectionate pets.

The Pembroke Welsh corgi resembles the Cardigan Welsh corgi. But the Pembroke has a slightly shorter body, a finer-textured coat, and a much shorter tail.

Critically reviewed by the Pembroke Welsh Corgi Club of America

See also **Cardigan Welsh corgi; Dog** (picture: Herding dogs).

Pemmican, *PEHM uh kuhn,* was one of the first forms of concentrated food. North American Indians made it from dried buffalo or deer meat. The Indians often hung the meat at the top of a tepee to dry over a campfire, which gave the meat a smoky flavor. They pounded the dried meat into a powder and mixed it with hot fat. When this mixture cooled, it was cut into cakes. Sometimes berries were added for flavor. Pemmican served as the main food when the tribes migrated. Pemmican keeps almost indefinitely and takes up little room.

Today, explorers, surveyors, hunters, and others often take pemmican with them on long trips. Pemmican is now usually made of beef. The people of South America make *tasajo,* which is much like pemmican, as is the *biltong* of South Africa. Helen C. Brittin

Pen is an instrument used for writing or drawing with ink. Pens of one type or another have been used for thousands of years. Today, pens rank among the most widely used writing instruments. The world's pen manufacturers produce billions of pens annually.

There are five main kinds of pens. They are (1) ballpoint pens, (2) fountain pens, (3) soft-tip pens, (4) roller ball pens, and (5) specialty pens.

Ballpoint pens have a tiny ball made of brass, steel, or tungsten carbide as their writing tip. A compartment called the *ink reservoir* holds the ink, and a narrow tube links the reservoir to the ball. The ball, which is fitted into a socket, turns as it rolls across the paper, carrying ink from inside the pen onto the paper. Many ballpoint pens have a plastic cap that helps prevent ink from drying out on the ball. On others, a push-button mechanism draws the pen point into the body of the pen.

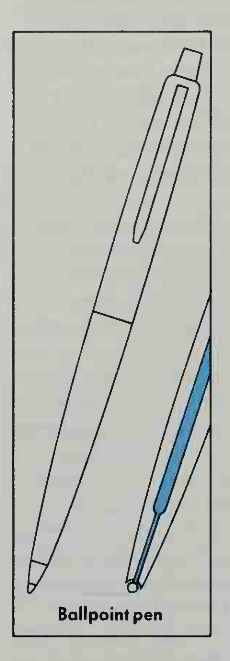
Most ballpoint pens depend on gravity to pull the ink to the ball. For this reason, ballpoint pens generally do not write well when held sideways. However, some ballpoints are designed so that slight pressure is always applied behind the ink column. This design enables the ink to move constantly forward and the pen to write even when its point is higher than its back end. Ballpoint pens use a thick, sticky ink because a thinner ink would leak out around the ball. But the use of such ink makes ballpoint pens write less smoothly than most other pens.

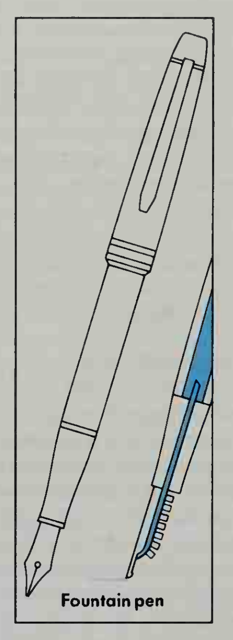
Fountain pens have a somewhat triangular writing point, called a *nib,* which is made of gold or stainless steel. A system of narrow tubes known as the *feed* carries the ink from the pen's reservoir to the nib.

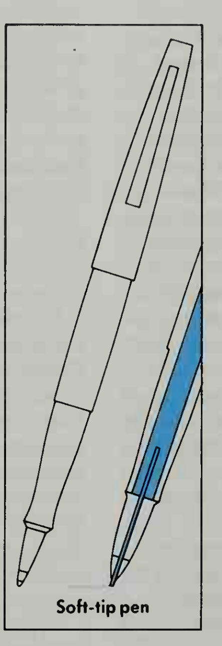
Fountain pens use a highly fluid ink. They rely on a property called *capillarity* to draw the ink into and

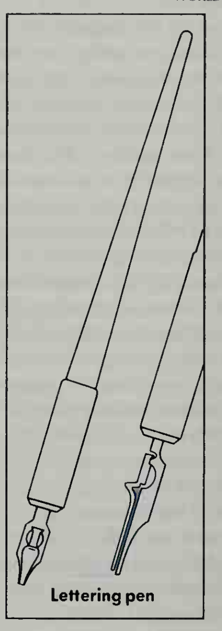
Some kinds of pens Pens are used for writing and drawing with ink. Pens differ in several ways, including the type of writing tips they have and the ink they use. Some common pens are shown here.

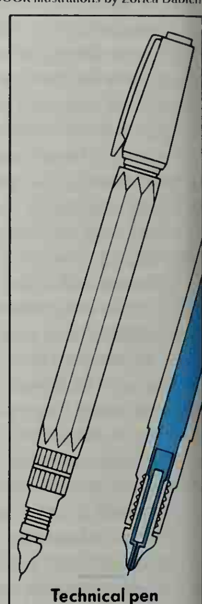
WORLD BOOK illustrations by Zorica Dabich


Ballpoint pen


Fountain pen


Soft-tip pen


Lettering pen


Technical pen

through the feed. Capillarity causes the inner surface of the tubes to attract molecules of ink. These ink molecules, in turn, attract other ink molecules, and the feed fills with ink from the pen's reservoir. See **Capillarity.**

The feed in a fountain pen also includes a number of air passages that lead to the reservoir. These passages allow air to fill the top of the reservoir as ink is drawn from the bottom. Thus the air pressure inside the pen remains equal to the air pressure outside the pen, and the ink flows easily. If the air pressure inside the ink reservoir is lower than the atmospheric pressure outside, the ink will not reach the point and the pen will fail to write. However, if the air pressure over the ink column becomes greater than the air pressure outside the pen, ink will flood out from the front of the pen. To avoid such flooding, fountain pens are designed with a *collector.* The collector, which is located near the nib, consists of a series of fins and spaces that provide enough additional room to accommodate forward moving ink.

Soft-tip pens, also called *porous-point pens,* have a relatively soft writing tip. Some soft-tip pens, called *felt-tip pens,* have a feltlike writing tip. The tip of others is made of absorbent plastic.

Soft-tip pens use fluid, brightly colored inks. The reservoir in a soft-tip pen consists of a synthetic material made up of many fibers. This *capillary reservoir* holds ink much as a sponge holds water. During writing, the absorbent tip of the pen draws ink from the reservoir onto the paper.

Roller ball pens combine certain features of ballpoint, fountain, and soft-tip pens. Like ballpoint pens, roller ball pens have a tiny ball that turns in a socket at their tip. But unlike ballpoints, roller ball pens use highly fluid inks, which allow them to write as smoothly as soft-tip and fountain pens.

Roller ball pens may have either a capillary reservoir similar to that used in soft-tip pens or a reservoir like that of ballpoints. A wick made of an absorbent material draws ink from the reservoir and carries it to the ball. The wick can carry only a limited amount of ink at any one time. In this way, the wick regulates the flow of ink and prevents it from leaking out.

Specialty pens are designed for specific purposes. For example, artists and mechanical drafters use a pen called a *technical pen.* This pen comes with a set of interchangeable pen points of varying widths. Another special pen, called a *lettering pen,* is used to create an elegant style of handwriting called *calligraphy.*

History. As early as 4000 B.C., ancient peoples used crude pens consisting of hollow straws or reeds that supported a short column of liquid. During the 500's B.C., people began to make pens from the wing feathers of such birds as geese and swans. The shaft of the feathers was hardened, and the writing tip was shaped and slit to make writing easy. These feather pens were known as *quill pens,* and they were widely used until the development of steel-nib pens in the 1800's.

By the late 1800's, inventors had perfected an early type of fountain pen. This pen represented a major advance because it had an ink reservoir and a capillary feed. Earlier pens held only a small amount of ink at a time and had to be repeatedly dipped in ink.

John H. Loud, an American inventor, patented a ballpoint pen in 1888. But ballpoint pens received little notice until World War II (1939-1945). Many pilots began using ballpoint pens during this conflict, because such pens did not leak at high altitudes. After the war, ballpoint pens became increasingly popular. Soft-tip pens and roller ball pens both were introduced in the 1960's.

Critically reviewed by the Writing Instrument Manufacturers Association

Pen name is a name an author uses instead of his or her real name. Pen names are also called *pseudonyms.*

housands of authors use pen names. Most are popular ovelists who adopt one or more pen names to avoid ooding the market with many works published under ne same name. Writers sometimes use pen names to onceal their identity for legal reasons, to protect their rivacy, or because they are dealing with highly person- l or controversial material.

During the 1800's, many women writers adopted mas- uline pen names because of sexual discrimination. For xample, the British novelist Mary Ann Evans concealed er femininity with the pen name George Eliot.

Pen names first became common in the 1700's with ne emergence of newspapers, magazines, and other eriodicals. Authors adopted pen names because they eared political persecution for their writings. Perhaps ne most famous early pen name was Voltaire, which vas adopted in 1718 by the French writer François Aarie Arouet. The English writer Charles Dodgson vrote under the pen name of Lewis Carroll. The Ameri- an author Samuel Clemens used the pen name Mark wain. The children's writer Theodor Seuss Geisel used ne pen name Dr. Seuss. The American mystery writers rederic Dannay and Manfred B. Lee wrote as Ellery Queen. John Creasey, another mystery writer, used 27 en names. Wayne H. Finke

See also Name (Pseudonyms).

Peña, *PAY nyah,* **Federico Fabian,** *fehd uh REE koh ah bee AHN* (1947-), served as United States secre- ary of transportation from January 1993 to January 1997 nd as secretary of energy from January 1997 to June 998, when he resigned. He was the first Hispanic Amer- can to hold either of these Cabinet offices. A Democrat, Peña served under President Bill Clinton. From 1983 to 991, he had been mayor of Denver, Colorado.

Peña was born in Laredo, Texas, and grew up in Brownsville. He attended the University of Texas at Austin, where he received a bachelor's degree in 1969 and a law degree in 1972. In 1973, he and his brother Al- redo established a law firm in Denver called Peña and Peña. As a lawyer, Federico handled civil rights cases hat dealt with police brutality and voting rights for His- panics. He also worked to promote bilingual education and better funding of public schools in Hispanic neigh- borhoods. In 1978, Peña was elected to the Colorado House of Representatives. He served as minority speak- er of the Colorado House from 1981 to 1983.

Barbara A. Reynolds

Penal colony is a settlement outside a country where he country sends its prisoners. From the 1500's to the mid-1900's, many European nations operated penal colonies to help relieve overcrowded prisons and to re- move convicts to faraway places. Countries sometimes used the prisoners as laborers to develop the natural re- sources of a colony.

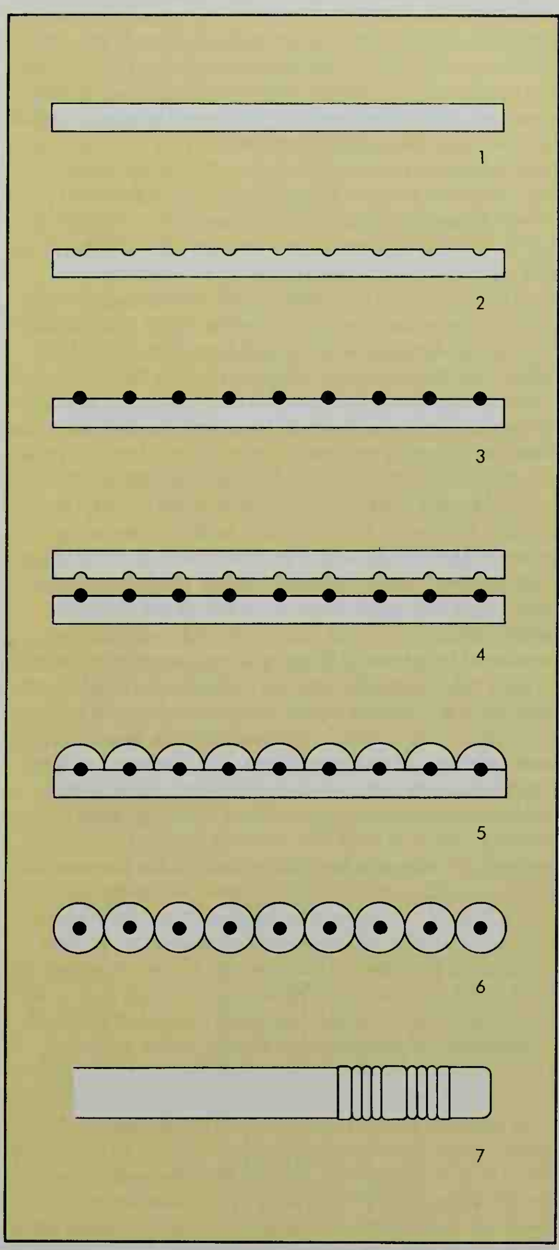
Britain sent many prisoners to the American Colonies n spite of the objections of colonists there. The Revolu- ionary War (1775-1783) ended penal colonies in Ameri- ca. The British then shipped criminals to Australia. These prisoners were the first white people to settle in Aus- ralia (see **Australia** [History]).

A well-known French penal colony was Devils Island n French Guiana. This colony was started by Napoleon II in 1852. In 1945, the prisoners at Devils Island were ransferred or liberated.

In the past, penal colonies were known for their bru- tal treatment of prisoners. The prisoners were often chained together and whipped. Today conditions have improved, but most of the remaining penal colonies are still places of harsh punishment. James O. Finckenauer

Penates. See Lares and penates.

Pencil is the most widely used writing and drawing in- strument in the world. People use pencils to write words, numbers, music, and poetry, and to draw pic-



WORLD BOOK illustration by J. Harlan Hunt

Making a cased pencil involves several steps. First, cedar logs are sawed into narrow slats (figure 1). Parallel grooves are cut into the slats (2). A graphite mixture is laid in the grooves of one slat (3), which is then glued to an empty slat (4). Individual pencils are cut from this pencil "sandwich" (5 and 6). Finally, an eraser is attached to the pencil by a ringlike *ferrule* (7).

tures, plans, maps, and diagrams. Astronauts have taken pencils into space because the writing ability of pencils is unaffected by gravity, pressure, or conditions in the atmosphere. Billions of pencils are produced annually throughout the world.

Pencils consist of a writing core made mostly of graphite set within a case of wood, metal, or plastic. There are three main types of pencils: (1) cased pencils, (2) colored pencils, and (3) mechanical pencils.

Cased pencils consist, in most instances, of a wood case and a black writing core. The core is composed of graphite and fine clay, sometimes combined with other chemicals. When graphite was first used in pencils, people mistakenly thought it contained lead. The graphite mixture is still called *lead* and the pencils, which contain no lead, are often called *lead pencils.*

Graphite for pencils is formed into spaghettilike strings, cut to precise measurements, and dried in ovens. Manufacturers vary the proportions of graphite and clay in the mixture to produce pencils with harder and softer writing cores. The Number 2 pencil is the standard and most common pencil used today. Pencils with numbers less than 2 have softer leads and contain less clay and more graphite. Soft pencils make a dark, heavy line. Harder pencils make a finer, lighter line.

Most cased pencils are made from incense-cedar. Cedar logs are sawed into narrow strips called *slats.* The slats are about 7 $\frac{1}{4}$ inches (18.4 centimeters) long, $\frac{1}{4}$ inch (6.4 millimeters) thick, and 2 $\frac{3}{4}$ inches (7 centimeters) wide. They are stained, waxed, and dried before shipment to the pencil factory. At the factory, parallel grooves are cut into one side of the slats and half of the slats are then coated with a fine layer of glue. Next the graphite is laid in the grooves of the glued slats, and pencil "sandwiches" are made. Pencil sandwiches are produced by pressing the empty slats onto the slats that already have graphite inserted in them. The sandwiches then go into a shaper, which forms the slats into individual *hexagonal* (six-sided) or round pencils. Most pencils are made into a hexagonal shape. The flat sides of such pencils prevent the pencils from rolling off surfaces.

After the individual pencils have been cut, they are painted. Yellow is the color most often used for pencils. Erasers are then attached to the pencils. Each eraser is surrounded by a round, metal case called a *ferrule,* which is held in place either by glue or by small metal prongs. Most ferrules are made of aluminum or steel.

Colored pencils are made in much the same way as black-writing pencils. But their cores contain such coloring materials as *dyes* and *pigments* instead of graphite.

Mechanical pencils have a metal or plastic case. They use leads similar to those used in cased pencils. Mechanical pencils require no sharpening. The lead rests inside a *spiral* (round coil) within the case and is held in place by a rod that has a *stud* (piece of metal) fastened to it. In most cases, depressing the end of the pencil causes the rod and stud to move downward in the spiral, forcing the lead toward the point. Some pencils work by other mechanical methods.

History. The earliest pencils date back to the ancient Greeks and Romans, who used flat cakes of lead to mark faint black lines on *papyrus* (an early form of paper) to guide writers. In the Middle Ages, people used thin rods of lead or silver for drawing.

The marking ability of graphite was discovered in the 1500's. By the early 1600's, cased graphite pencils were being made in Britain and Germany. In 1662, Frederick Staedtler established what can be considered the first pencil factory, in Nuremberg, Germany. Although Staedtler's workers made pencils by hand, they carried out all the steps in the production at one location.

In 1795, Nicholas Jacques Conte, a French chemist, developed a pencil of powdered graphite and clay. His mixture proved to be as smooth and hard as pure graphite. Conte also discovered that a harder or softer writing core could be produced by varying the proportions of clay and graphite.

In the 1800's, several inventors created machines for shaping and smoothing the wooden components of pencils. In 1822, Sampson Mordan, a British engineer, received the first patent for a mechanical pencil.

Critically reviewed by the Writing Instrument Manufacturers Association

See also **Eraser; Graphite; Faber, Eberhard.**

Penderecki, *pehn deh REHTS kih,* **Krzysztof,** *kruh ZIHSH tawf* (1933-), is a Polish composer. He became known for using unconventional instrumental and vocal sound effects in his works. For example, in his *String Quartet No. 1* (1960), the musicians slap their instruments and tap them with their bows. In *Dimensions of Time and Silence* (1960), a chorus sings only single-syllable consonants. In other works, singers hiss or whistle. His most famous piece is *Threnody for the Victims of Hiroshima* (1960) for 52 string instruments.

Penderecki has written several religious works, including *St. Luke Passion* (1966) and *Utrenja* (1970-1971). For the 25th anniversary of the United Nations, Penderecki wrote *Kosmogonia* (1970) for solo singers, chorus, and orchestra. Penderecki has composed two operas, *The Devils of Loudun* (1969) and *Paradise Lost* (1978). The latter opera reflects Penderecki's turn away from a dissonant style toward a more *neoromantic* style. He was born in Dębica. Stephen Jaffe

Pendergast, Thomas Joseph (1872-1945), was a Kansas City, Missouri, politician who rose from poverty to become one of the most powerful political bosses in the United States. He helped future United States President Harry S. Truman win several elections, including a run for the U.S. Senate in 1934.

Thomas (Big Tom) Pendergast was born to an Irish immigrant family in St. Joseph, Missouri. In 1911, he succeeded his brother James (Big Jim) Pendergast as the head of a Democratic Party political *machine* in Kansas City. A political machine is a group that does favors for citizens in return for votes. The Pendergast machine won elections by dispensing jobs and assistance. Members took money from illegal bribes. Pendergast ruled with an iron fist, using violence when necessary and making deals with gangsters and political officials. He won public favor by backing improvement projects that benefited Kansas City.

Violence, fraud, and corruption eventually caught up with the Pendergast machine. In 1937 and 1938, 259 machine members were convicted on federal vote fraud charges. Pendergast was sentenced to 15 months in jail and 5 years probation for tax evasion in 1939. Without his leadership, his machine fell from power.

Alonzo L. Hamby

See also **Truman, Harry S.** (Political career).

'endleton, George Hunt (1825-1889), a United ;tates senator, sponsored the Pendleton Act, which cre- ted the civil service system in 1883. He also sponsored proposal in 1867 to pay off the U.S. national debt with ›aper money rather than gold. A Democrat from Ohio, 'endleton served in the United States House of Repre- entatives from 1857 to 1865 and in the Senate from 1879 o 1885. He was the Democratic Party's candidate for ice president in 1864, but he lost the election. From 885 to 1889, Pendleton served as minister to Germany. le was born in Cincinnati, Ohio.

Edward A. Lukes-Lukaszewski

'endulum, *PEHN juh luhm* or *PEHN dyuh luhm.* If an ›bject that pivots around a fixed point is pulled aside ınd let go, gravity makes it swing back and forth at a egular rate. Such a body is called a *pendulum.* The *sim- ɔle pendulum* consists of a weight hanging at the end of ı string or wire. The path traveled by the weight is :alled the *arc of the pendulum.* The *period of oscillation* s the time it takes the weight to pass back and forth ɔnce over this arc.

The period depends upon the pendulum's length and ocation. If a pendulum were taken from one place to ınother on the earth, the period would change slightly due to a change in the pull of gravity. For example, the ɔeriod would increase if the pendulum were taken from sea level to the top of a mountain. It increases because the force of gravity becomes weaker at greater heights. A simple pendulum 9.79 inches (24.87 centimeters) long has a period of 1 second at sea level.

If the swing is small, the period varies with the square root of the length of the pendulum. For example, the pe- riod of a 9-inch pendulum is $1\frac{1}{2}$ times as long as the pe- riod of a 4-inch pendulum. (The square root of 9 is 3, the square root of 4 is 2, and 3 is $1\frac{1}{2}$ times as large as 2.)

The equation that expresses this relationship is:

$$t = 2\pi\sqrt{\frac{l}{g}}$$

where t is time, the period of the pendulum, in seconds; l is the length of the pendulum in feet (meters); and g is the *acceleration due to gravity,* a factor that depends on the gravity where the pendulum is located. At sea level, g = 32.16 feet (9.802 meters) per second per second.

The Italian physicist Galileo discovered the laws of the pendulum. He noticed that a hanging lamp would swing with an almost constant period, whether the arc was large or small. He believed that a pendulum could regu- late the movements of clocks. The Dutch scientist Chris- tiaan Huygens patented the first pendulum clock in 1657. Galileo's observations are still correct as long as the pendulum's swing is small. But modern measuring in- struments have shown that the period of a pendulum in- creases when it has a large swing.

Clock pendulums usually consist of a rod with a heavy weight at one end and a hard bearing at the other. A screw at the end of the rod permits the weight, or *bob,* to be raised or lowered. When the bob is lowered, the pendulum swings more slowly, and the clock runs more slowly. When the bob is raised, the pendulum swings faster, and the clock runs faster.

The bearing on which the pendulum swings must be as nearly frictionless as possible. It is often made of a knife edge of agate set in a grooved agate plate.

A device called an *escapement* is fastened to the mechanism of the clock. It gives small but regular push- es to the pendulum and keeps it swinging. The escape- ment lets one tooth of a toothed-wheel turn past it each time the pendulum swings aside. This action gives the clock its "tick-tock" sound.

The rod in a clock pendulum tends to expand when it is warmed and to shorten when it is cooled. If no cor- rection is made, pendulum clocks will run slower in hot weather and faster in cold weather. Several means have been developed to make up for this effect. For example, clocks known as *regulators* usually come with so-called *gridiron* pendulums. These pendulums consist of sever- al brass and steel rods. The rods are arranged so that the brass rods raise the bob and the steel rods lower it as the temperature increases.

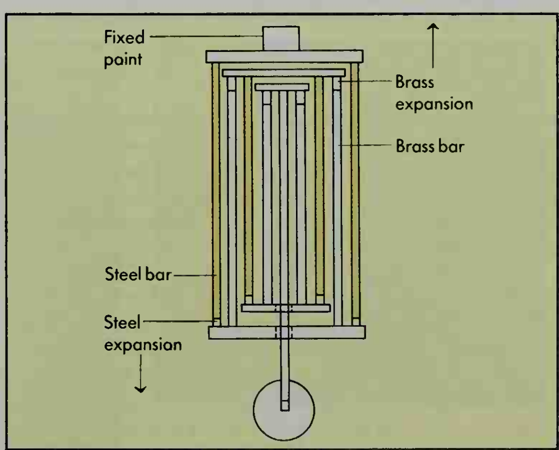
Other pendulums. In *torsion pendulums,* a wheel or a balanced set of weights is suspended on a wire. The wire becomes twisted like a spring as the weight rotates

a

b

c

A simple pendulum swings back and forth from a fixed point *a,* and forms an arc between *b* and *c.* The time the pendulum takes to go from *b* to *c* and back to *b* again is called its *period.*



WORLD BOOK diagrams by Arthur Grebetz

A gridiron pendulum has brass and steel rods that expand or contract in opposite directions as temperatures change. The pendulum's length and period are thereby kept constant.

around it. Torsion pendulums are used in the so-called 400-day clock and in other measuring instruments.

In *bifilar* (pronounced *by FY luhr*) *pendulums,* two parallel wires hold the bob. They are pulled tight to provide a more controlled motion. A bifilar pendulum is sensitive to variations of the *plumb line* (line toward the earth's center of gravity). Bifilar pendulums have been used to show that the earth does not rotate on its axis at a constant speed. Such changes in the earth's rotation result from the pull of gravity exerted on the spinning earth by the sun and moon.

In 1851, the French scientist Jean Foucault hung a large iron ball on a wire about 200 feet (60 meters) long. With this pendulum, he showed that the earth rotates on its axis. A Foucault pendulum is similar to a simple pendulum, but its motion is not limited to a plane. The plane of its swing appears to change as the earth goes through its daily rotation. However, the pendulum actually continues to move in the plane in which it was set in motion, while the earth turns under it. At the equator, a Foucault pendulum does not change its apparent plane of swing. The change would be fastest at the North and South poles (see **Coriolis effect**). James D. Chalupnik

See also **Clock; Foucault, Jean B. L.; Galileo; Gravitation; Huygens, Christiaan.**

Penelope, *puh NELL uh pee,* in Greek mythology, was the wife of Odysseus (Ulysses in Latin), king of Ithaca. She became famous for her faithfulness to her husband. After the birth of their son, Telemachus, Odysseus left on an expedition against Troy. He did not return for 20 years, but Penelope remained faithful to him. Her story is told in the epic poem the *Odyssey.*

Many nobles from Ithaca and neighboring islands courted Penelope, claiming that Odysseus would never return, but she refused to remarry. For three years, she held suitors off by a trick. She said that she must first weave a shroud for her father-in-law, Laertes. Each night she unraveled what she had woven that day.

After a maidservant revealed Penelope's deception, she promised to select the suitor who could string and shoot Odysseus's great bow. Each suitor tried and failed. A beggar, who had come to the palace and was given shelter, asked to try. He easily strung and shot the bow. The beggar was Odysseus in disguise. With the bow, he killed the suitors. Odysseus regained his kingdom and was reunited with Penelope. Cynthia W. Shelmerdine

See also **Odyssey; Ulysses.**

Penfield, Wilder Graves (1891-1976), was a Canadian neuroscientist and physician who developed a surgical cure for some forms of epilepsy. In these forms, epileptic seizures originate in small clusters of damaged brain cells. Penfield developed techniques for locating damaged brain cells and removing them surgically.

Penfield also mapped the areas of the brain that control various bodily activities. He showed that the brain's control of such activities as speech and memory is temporarily stopped when electric currents are applied to certain parts of the brain. In this way, Penfield located a speech area of the brain in the rear of the left half of the cerebrum. He also discovered that electric stimulation of the *temporal lobe,* a part of the cerebrum, activated memories of earlier experiences. He concluded that some memory is stored in the temporal lobe.

Penfield was born in Spokane, Washington. He graduated from Oxford University in 1916 and received his M.D. degree from Johns Hopkins University in 1918. Penfield became a Canadian citizen in 1934. That year, he founded the Montreal Neurological Institute, which he directed until his retirement in 1960. Dale C. Smith

Penguin is a type of flightless bird that spends most of its life in the ocean. Penguins stand upright on land and walk with a waddle because they have short legs and tall, torpedo-shaped bodies. Penguins appear awkward out of the water, but they can walk about as fast as a human being. They also climb rocky slopes easily, sometimes hopping from rock to rock. Some penguins travel over ice and snow by *tobogganing* (sliding on their bellies).

Penguins lost the ability to fly millions of years ago. As they began to spend most of their time in the water, their wings started to look more like flippers. This major change helped make penguins excellent swimmers. They "fly" underwater using the same motion as birds that fly in the air.

The body of a penguin is specially suited to living in the sea. Penguins are covered with short, thick feathers that form a waterproof coat. Their feathers are black or bluish-gray, except on their underside, where the feathers are white. Some penguin species have yellow or orange feathers on the head, neck, or breast. Thick layers of blubber keep the birds warm in cold water. For additional warmth, penguins that live where the weather is extremely cold have an extra layer of long, downy feathers below their waterproof feathers.

A penguin's beak can be black, red, bright purple, or orange. The feet are black, blue, or pink. Penguins use their feet to steer themselves when they are underwater. Some penguins have a crest of feathers on their head.

There are 17 *species* (kinds) of penguins. The largest is the *emperor penguin,* which stands about 4 feet (1.2 meters) tall and may weigh up to 100 pounds (45 kilograms). The emperor penguin ranks as one of the heaviest birds. The smallest penguin is the *little penguin,* sometimes called the *fairy penguin,* which stands about 1 foot (30 centimeters) tall and usually weighs about 3 pounds (1.4 kilograms). Most other species are $1\frac{1}{2}$ to 3 feet (45 to 90 centimeters) tall and weigh 5 to 15 pounds (2.3 to 6.8 kilograms).

Penguins can swim for many hours at about 8 miles (13 kilometers) per hour. In short bursts, they can reach three times that speed. Penguins swim below the surface, but they leap into the air for breath about once a minute. They can also dive much deeper than any other bird. Some species dive nearly 900 feet (275 meters) below the surface. The deepest divers can hold their breath for nearly 20 minutes.

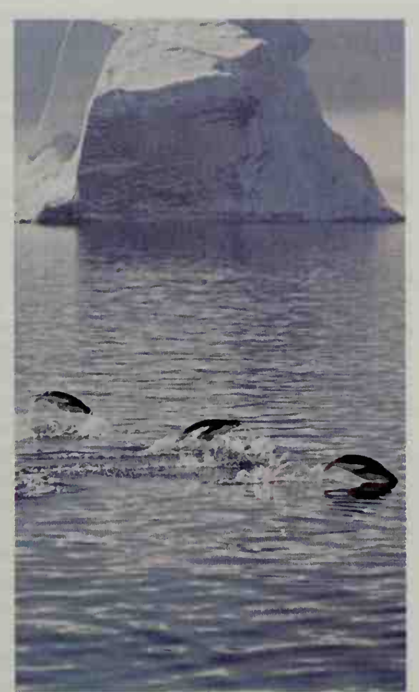
The life of penguins. Penguins eat fish, squid, and *crustaceans,* which include crabs and shrimp. The birds use so much energy swimming that they must consume huge amounts of food. As a result, they live in waters that contain large populations of prey. Animals that feed on penguins include seals, sea lions, and killer whales.

All penguins in the wild live south of the equator. They are not found in northern areas because they will not cross into warm ocean water from the cold seas they prefer. The *Galapagos penguin* lives the farthest north. This bird inhabits the cold waters around the Galapagos Islands, which lie almost on the equator in the



Peter Johnson, NHPA

Most species of penguins build their nests and raise their young in huge colo-ies called *rookeries.* This picture shows part of an enormous rookery of king pen-uins on South Georgia, an island in the South Atlantic Ocean.

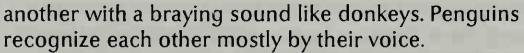


William R. Curtsinger from Rapho Guillumette

Penguins are excellent swimmers. Adélie penguins, *above,* swim rapidly in leaps and dives along the surface of the water.

astern Pacific Ocean. Eight species of penguins make heir home among the islands near New Zealand and ustralia. Three species inhabit the coast of South merica, and one lives near southern Africa. Six species ve far south, in the icy waters near Antarctica.

Penguins seldom visit land except to raise their oung. They make their nests in enormous gatherings alled *colonies.* Most colonies occur on islands. Some e in coastal areas, but only where there are no land nammals that might eat the penguin chicks or eggs. A enguin colony can have thousands of members. The olonies are noisy because the birds often call to one

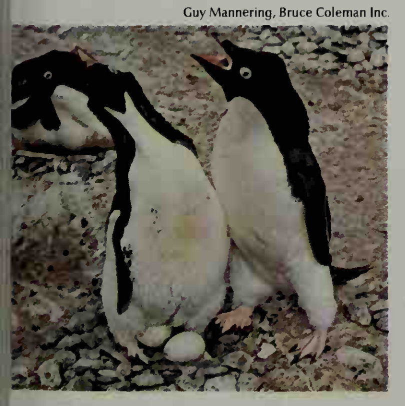


another with a braying sound like donkeys. Penguins recognize each other mostly by their voice.

Most penguins make their nests by digging shallow burrows under large rocks or bushes. Antarctic penguins build nests of pebbles on the ground because the frozen earth is too difficult to dig. The king penguin and emperor penguin build no nests at all. They keep their eggs or small chicks warm under a fold of their belly, holding them on the tops of their feet.

A pair of male and female penguins may nest together every year for many years. The female usually lays one or two eggs. Penguin eggs take from 30 to 65

Guy Mannering, Bruce Coleman Inc.



A pair of Adélie penguins stand over the wo eggs in their nest. A female penguin lays rom one to three eggs, depending on the pecies, but most penguins lay two. The eggs atch in one or two months.



Michael C. T. Smith, NAS





Morton Beebe, DPI

Adult penguins provide food and warmth for their young. A small emperor penguin huddles under the warm body of an adult, *left.* An Adélie penguin feeds its young, *above,* by vomiting partially digested fish.

days to hatch. Larger species take longer to hatch and to grow. Once laid, the egg must be *incubated* (kept at body temperature). Both parents take turns searching for food and caring for the eggs. The parent at the nest does not eat while the other parent is away, sometimes for a month at a time or longer.

When a chick hatches, the parents must guard it until it is strong enough to defend itself. It remains near the nest for the first 2 to 12 months of its life, depending on the species. The chick is covered by downy feathers that are slowly replaced by mature ones. It eats partially digested food fed to it by its parents. When young penguins are old enough, they leave the colony and learn to feed themselves at sea. They return to land only to *molt* (shed their feathers) and to *breed* (produce young). Penguins usually choose a mate and a nesting site close to where they were born. Though penguins sometimes travel thousands of miles or kilometers from their nesting place, they are able to return to their exact birthplace. Scientists believe penguins can navigate using the sun, stars, and geographical landmarks.

Some penguins kept in zoos have lived for more than 30 years. But in the wild, most species have a life span of about 20 years.

Conservation. Penguins are one of the oldest groups of birds. They have lived separately from land mammals, including human beings, for millions of years. Penguin populations are easily disturbed by human activity. For example, even a small amount of oil in the ocean is harmful to the birds. It robs their feathers of the ability to keep them warm. Also, commercial fishing in waters where penguins live makes it harder for them to find enough food. Because human activity has spread into areas where penguins live, some penguin species are in danger of dying out. David G. Ainley

Scientific classification. Penguins belong to the family Spheniscidae. The scientific name of the emperor penguin is *Aptenodytes forsteri*. The king penguin is *A. patagonica*. The little penguin is *Eudyptula minor*. The Galapagos penguin is *Spheniscus mendiculus*.

See also Antarctica (Animal life).

Penicillin is a powerful drug used to treat infections caused by bacteria. It was the first *antibiotic* (drug produced by microbes) used successfully to treat serious diseases in human beings. Sir Alexander Fleming, a British scientist, discovered penicillin in 1928. Various forms of the drug, called penicillins, have become widely available for medical use since the mid-1940's. Penicillins have played a major role in treating pneumonia, rheumatic fever, scarlet fever, and other diseases. The development of penicillins had a tremendous impact on medicine and encouraged research that led to the discovery of many other antibiotics.

Forms of penicillin. There are many kinds of penicillin. They all come from molds of the *genus* (scientific group) named *Penicillium* (PEHN *uh SIHL ee uhm*). Chemists isolate some natural penicillin substances by processing *Penicillium* molds in various ways. They produce other forms, called *semisynthetic penicillins,* by changing natural penicillin substances through chemical processes. *Penicillin G* is the most widely used natural penicillin. Commonly used semisynthetic penicillins are *ampicillin* (AM *puh SIHL ihn*), *amoxicillin* (*uh MAHK suh* SIHL *ihn*), *penicillin V*, and *nafcillin* (*NAF sihl ihn*). Semisynthetic penicillins called *extended spectrum* and *broad spectrum penicillins* are effective against many types of bacteria. Two examples of such penicillins are *ticarcillin* (TIHK *uhr SIHL ihn*) and *piperacillin* (PIHP *uhr uh SIHL ihn*).

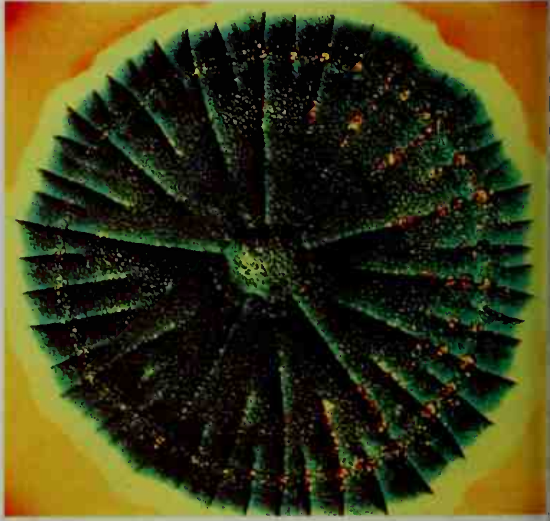
How penicillins work. Penicillins kill bacteria by preventing the formation of the stiff cell walls bacteria need to survive. Human cells do not form stiff cell walls, and so they remain undamaged by penicillins.

Some penicillins can be taken *orally* (by mouth). But stomach acids destroy other penicillins taken orally before they reach the bloodstream. Doctors usually give such penicillins as injections.

Most people who take penicillins experience no side effects, though some people suffer allergic reactions. These reactions are usually minor, causing fever or rashes. However, life-threatening reactions involving shock and breathing difficulties occur in some patients. Patients allergic to one form of penicillin will likely react to all forms. As a result, doctors treat some patients allergic to penicillin with antibiotics called *cephalosporins* (SEHF *uh luh SPAWR ihnz*). These antibiotics are similar to penicillin and have been in use since the 1960's.

Early history. Fleming discovered penicillin in 1928 when he noticed mold growing in a lab dish containing common bacteria. He saw that the bacteria around the mold had died. In the 1930's, British researchers led by Howard Florey and Ernst Chain found a way to *extract* (pull out) and purify small amounts of penicillin. In 1941, a British policeman with blood poisoning became one of the first people treated with the drug. He began to recover but died because the hospital lacked an adequate supply of penicillin.

During the next several years, researchers found ways to produce large quantities of some penicillins. One of these, penicillin G, proved the most effective. But penicillin G was not effective when given orally, and it did not kill certain bacteria. In the late 1950's, chemists be-



Pfizer Inc.

Penicillin is one of the most widely used antibacterial drugs. It is produced by molds of the genus *Penicillium, shown here.* Manufacturers grow the mold in huge tanks of broth.



Pfizer Inc.

In a penicillin factory, workers wear masks and lint-free clothes to keep the antibiotic free from impurities. A worker, *shown here,* observes liquids being mixed in a huge tank.

gan making semisynthetic penicillins to overcome these problems. Most semisynthetic penicillins have one or more properties not found in penicillin G. For example, penicillin V kills the same bacteria as penicillin G, but blood absorbs it better. Ampicillin and amoxicillin are effective against some kinds of bacteria that penicillin G cannot kill. Doctors use these drugs to treat urinary tract infections, and throat and ear infections in children.

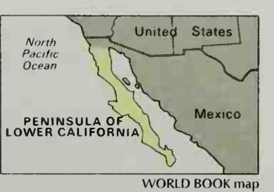
Resistance. Since the 1950's, many bacteria have become resistant to penicillin. Resistant bacteria are unaffected by certain penicillins or other antibiotics. Resistance can occur when the genes of a bacterium change in a way that makes it unaffected by a certain antibiotic. The bacterium's offspring will also be unaffected by that drug. Bacteria can also become resistant by exchanging genetic material with other bacteria. One example of a kind of bacteria that often resists penicillin is *Streptococcus pneumoniae (STREHP tuh KAHK uhs noo MOH nee eye),* a cause of pneumonia. Most *Staphylococcus aureus (STAF uh luh KAHK uhs AW ree uhs)* bacteria, which cause skin and bloodstream infections, are penicillin resistant. Penicillins are now ineffective in treating a commonly sexually transmitted disease called *gonorrhea (GAHN uh REE uh).*

The widespread use of antibiotics to treat infections in human beings and livestock increases the number of resistant bacteria. Resistance to antibiotics is a growing threat to public health. Nelson M. Gantz

Related articles in *World Book* include:

Ampicillin	Fleming, Sir Alexander	Medicine (picture: Penicillium mold)
Antibiotic	Florey, Lord	Tyndall, John
Cephalosporin		
Chain, Ernst B.		

Peninsula, *puh NIHN suh luh,* is an area of land that is nearly surrounded by water. Peninsulas are usually long, narrow strips, but they also may span vast areas. Some peninsulas are joined to the mainland by a broad base. Others are connected by a narrow strip of land, called an *isthmus* (see **Isthmus**). Arabia, the largest peninsula, covers about 1,000,000 square miles (2,600,000 square kilometers). Anthony J. Lewis



WORLD BOOK map

A typical peninsula

Peninsular campaign. See **Civil War.**

Peninsular War. See **Napoleon I** (The Peninsular War); **Spain** (French conquest).

Penis is an external male reproductive organ. In men and most other male mammals, both urine and a sperm-carrying fluid called *semen* leave the body through the penis. The penis is shaped somewhat like a finger. It hangs between the legs and is attached to the pelvic bones by connective tissues.

Thin, hairless skin covers the penis. Inside are three adjoining cylinders of spongy tissue that contains many blood vessels. These cylinders are bound together by a fibrous sheath. One of them encloses the *urethra,* a passageway for semen and urine. The urethra ends as an opening in the tip of the penis. The tip, called the *head* or *glans,* is slightly enlarged and has highly sensitive nerve endings. A fold of skin called the *foreskin* or *prepuce* covers the glans. In many males, the foreskin has been removed by a surgical procedure called *circumcision* (see **Circumcision**).

The penis is usually soft and limp. Sexual excitement increases the flow of blood to the organ, filling its tissues and making it stiff and erect. The stiffened penis, called an *erection,* enables the male to have sexual intercourse. In a sexually mature male, stimulation of the erect penis leads to *ejaculation,* the discharge of semen that accompanies sexual climax. After ejaculation, blood drainage returns the penis to its normal state.

Earl F. Wendel

See also **Bladder; Impotence; Prostate gland; Reproduction, Human; Sexuality.**

Penitentiary. See **Prison.**

Penn, John (1740-1788), a North Carolina delegate to the Continental Congress from 1775 to 1780, was a signer of the Declaration of Independence. When Penn was 21, he received a license to practice law. He practiced successfully for about 12 years in Virginia. In 1774, he moved to North Carolina, where he became a Revolutionary leader and served as a member of the provincial congress. He returned to his law practice after the Revolutionary War. Penn was born in Caroline County, Virginia. James H. Hutson

Penn, William (1644-1718), was a famous English Quaker who founded Pennsylvania. The Quakers, or Friends, were often treated harshly in England. They wanted the right to follow their religious beliefs without scorn or fear of violence. Penn, one of their leaders, persuaded King Charles II to let them set up a colony in America. This colony became the state of Pennsylvania.

Youthful rebel. Penn was born on Oct. 14, 1644, in London, the son of a naval officer later knighted as



Historical Society of Pennsylvania, Philadelphia

William Penn, an English Quaker, founded the colony of Pennsylvania in 1681. The above portrait of Penn was drawn in chalk about 1700 by Francis Place, an English artist.

Admiral Sir William Penn. The boy went to school in Essex. He entered Christ Church, Oxford University, in 1660. This was the year the Stuart family returned to the throne of England. Penn opposed the university rule that everyone must attend the Church of England. He believed in religious freedom and the right of individuals to worship as they pleased. Penn met with other rebellious students, outside the university, and was expelled from school. His father then sent Penn to France and Italy, hoping that the fashionable life there would make the boy forget his religious beliefs, or at least change them. Penn returned after two years of travel and study. The signs of his religious zeal were gone. His father, glad for this change, sent him to study law in London.

Penn went to Ireland in 1667 to manage his father's estates. There, he became acquainted with Thomas Loe, a Quaker preacher. Loe convinced him of the "truth" of the Quaker faith. Penn was then 22 years old. He chose to become a Quaker at a time when Quakers were scorned, ridiculed, imprisoned, and sometimes banished. His father was heartbroken.

Persecution. Penn was imprisoned several times for writing and preaching about Quakerism. He was first imprisoned in the Tower of London. After eight months, his father managed to have him released. During this imprisonment, Penn wrote *No Cross, No Crown* (1668), a piece explaining Quaker beliefs and practices.

In 1670, he was arrested at a Quaker meeting and accused of planning with another Quaker to start a riot. A jury found Penn not guilty of any crime. But the judge threatened to fine or imprison the jurors unless they changed their verdict. When they refused to do so, the jurors were in fact imprisoned. But on appeal, England's highest judges prohibited the penalizing of jurors. This action helped establish the independence of juries.

In 1677, Penn went to the Netherlands and Germany with George Fox and other Quaker leaders (see **Fox, George**). In these countries, Penn met other Quakers who were eager to settle in a free, new land. Some people in England also wanted to settle where they could worship in their own way without fear. Penn realized that the only hope for the Quakers was in America.

Founds Pennsylvania. Charles II owed Penn's father an unpaid debt of about $80,000. In 1680, Penn asked the king to repay the debt with wilderness land in America. On March 4, 1681, a charter was granted, giving Penn the territory west of the Delaware River between New York and Maryland. The charter also gave him almost unlimited ruling power over it. The king's council added *Penn* to the suggested name of *Sylvania,* making *Pennsylvania,* which means *Penn's Woods.* Penn drew settlers, including many Quakers, with promises of religious liberty and cheap land. Several thousand people came from England, Germany, the Netherlands, and Wales. Penn drew up a frame of government for his colony which greatly influenced later charters. It authorized an elected assembly and may even have influenced the Constitution of the United States.

In October 1682, Penn sailed up the Delaware River, and saw his colony for the first time. That same year, he made his first treaty with the Indians. His dealings with the Indians were so fair that they never attacked the colony. Penn returned to England in 1684 after the colony was well started. See **Pennsylvania** (History); **Philadelphia** (History).

Arrested again. In his drive for religious tolerance, Penn had become a close ally of King James II of England, a Roman Catholic. James granted pardons to Quakers and other religious prisoners. But in the Glorious Revolution of 1688, James was forced to give up the throne and flee abroad. His daughter Mary and her husband, Prince William of Orange, who were Protestants, became joint rulers of England in 1689. Penn was suspected of plotting the return of James, and was arrested several times. In 1692, his colony was placed under royal control. Penn wrote two of his greatest works in 1693. One was *An Essay Towards the Present and Future Peace of Europe,* a plan for a league of nations in Europe based on international justice. The other, *Some Fruits of Solitude,* described general principles for proper living. In 1694, Penn's colony was restored to him. That same year, Penn's wife, Gulielma Maria Springett Penn, died. They had married in 1672 and had eight children. In 1696, Penn married Hannah Callowhill, who was to bear him seven more children.

Penn returned to Pennsylvania in 1699. Problems had arisen in the colony over government, piracy, and illegal trade. Penn had some success solving these issues. He granted a new constitution, the Charter of Privileges, in 1701. This document created a *unicameral* (one-house) elected assembly with greater power. The provincial council was reduced from a legislative body to a small group of advisers to the governor. Efforts by the English government to place all proprietary colonies under royal control caused Penn to return to England in 1701. He never saw America again.

The government attempt to gain control failed. But



Landing of William Penn (about 1919), an oil painting on canvas by J. L. G. Ferris; Smithsonian Institution, Washington, D.C. (Archives of 76, Bay Village, Ohio © J. L. G. Ferris)

'enn first saw Pennsylvania when he arrived there from England in 1682. He had set up the olony to provide a place where Quakers and people of other faiths could have religious freedom.

'enn was arranging to sell Pennsylvania to the British rown in 1712, when he suffered a stroke. The stroke im-aired his mental ability and eventually paralyzed him. rom 1712 until his death, Penn's affairs in Pennsylvania vere handled by his wife and by his colonial secretary, ames Logan. Pennsylvania remained a proprietary olony in the Penn family until it gained statehood dur-ng the Revolutionary War in America (1775-1783).

Craig W. Horle

See also **Delaware** (English rule); **United States, Histo-y of the** (picture: Early colonists).

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'ennell, *PEHN uhl,* **Joseph** (1857-1926), was an Ameri-an printmaker. Pennell became best known for his lith-graphs and etchings, but he also created silk-screen rints, engravings called *mezzotints,* drawings, and wa-er colors. Pennell experimented with various inks and ntique papers to produce unusual effects in some of is prints. His most famous works include lithographs of actories, New York City skyscrapers, and scenes of the onstruction of the Panama Canal.

Pennell was born in Philadelphia, where he studied rawing and etching. He moved to London in 1884. here, Pennell became a close friend of the artist James . M. Whistler, who strongly influenced his style. While in London, Pennell and his wife, Elizabeth Robins, wrote several books on lithography and etching. They also col-laborated on a two-volume biography of Whistler, which was published in 1908. Pennell and his wife re-turned to the United States in 1917. Elizabeth Broun

Penney, James Cash (1875-1971), an American mer-chant, established the J. C. Penney Company. Penney be-gan his career as a clerk in a general store. He bought a partnership in a store in Wyoming in 1902, and later es-tablished new stores in partnership with men he trained. These stores were first called the *Golden Rule* stores. Penney headed 1,612 stores at the time of his retirement in 1946. The J. C. Penney Company still ranks as one of the nation's leading retailing firms. After his retirement, Penney established the James C. Penney Foundation to aid religious, scientific, and educational projects. He wrote an autobiography, *Fifty Years with the Golden Rule* (1950). Penney was born in Hamilton, Missouri.

John N. Ingham

Pennine Alps. See **Switzerland** (The Swiss Alps).

Pennine Chain, *PEH nyn,* is a long line of uplands in northern England. The Pennines run through the central part of England like a backbone, starting in Northumber-land and Cumbria counties and extending south to Der-byshire and Staffordshire. The highest point is Cross Fell, which has an elevation of 2,930 feet (893 meters). The Pennine Chain is rich in minerals, especially coal and lead. It is an important recreational area and con-tains two national parks—Peak District National Park and Yorkshire Dales National Park. M. Trevor Wild

See also **England** (picture: The Pennine Chain).



© Walter Choroszewski, The Stock Market

A scenic Lancaster County farm lies amid the rolling plains of Pennsylvania's Piedmont region. This area in the southeastern part of the state has some of the nation's richest farmland.

Pennsylvania *The Keystone State*

Pennsylvania is a leading manufacturing and industrial center of the United States. It also ranks as one of the nation's most historic states. It is one of four states officially called *commonwealths.* The other three are Kentucky, Massachusetts, and Virginia. Harrisburg is the state capital, and Philadelphia is the largest city.

Pennsylvania's chief manufacturing activities include the production of chemicals, electrical equipment, and processed foods. Service industries, such as banking, education, health care, and retail trade, also play a leading role in the state's economy.

Eastern Pennsylvania supplies all the *anthracite* (hard coal) that is produced in the United States. Mines in western Pennsylvania produce huge quantities of *bituminous* (soft) coal. Bituminous coal is used in generating electricity and in making coke, an important fuel used in the steel industry.

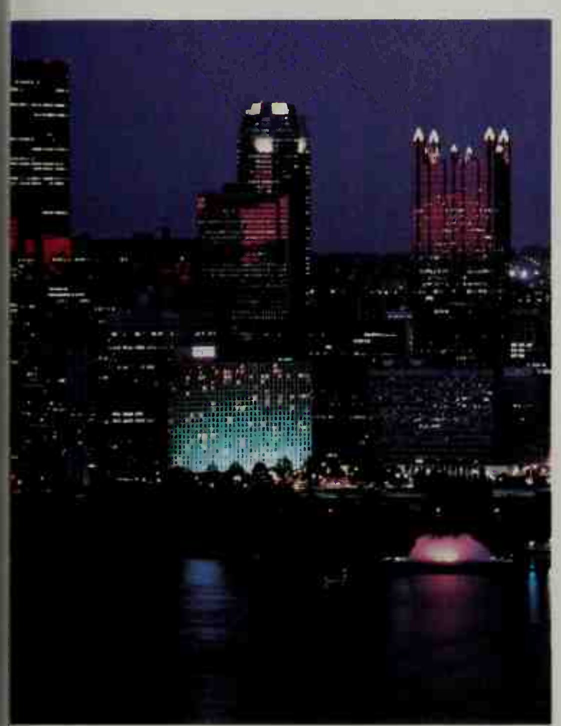
Philadelphia, in southeast Pennsylvania, is the state's leading manufacturing city. It is one of the nation's great cultural, educational, financial, and historical centers and also a chief port city. Pittsburgh, on the Ohio River in western Pennsylvania, is an important financial center. It is also a center of manufacturing. Hershey, in southeastern Pennsylvania, is the site of the world's largest chocolate and confectionery factory.

Most of Pennsylvania is made up of hills, plateaus, ridges, and valleys. The northwestern and southeastern corners of the state are low and flat. The lowest point in the state is sea level along the Delaware River. Mount Davis, in southern Pennsylvania, rises 3,213 feet (979 meters) above sea level and is the highest point in the state. Forests cover about three-fifths of Pennsylvania. Much of the state has rich farmland. The southeastern section has some of the richest soil in the United States. Crops prosper there. Poultry and cattle are also raised in the southeast. Dairy farming thrives in eastern Pennsylvania. The soil along Lake Erie in the northwest is good for growing fruits and vegetables.

Many tourists travel through the section of southeastern Pennsylvania in which the *Pennsylvania Dutch* people live. Most Pennsylvania Dutch people are descended from German immigrants. These immigrants were called *Dutch* because the word *Deutsch,* which means *German,* was misinterpreted. The Pennsylvania Dutch are known for fine cooking and for the colorful designs and decorations on many of their buildings and belongings. Some Pennsylvania Dutch groups, including the Amish and Mennonites, are called the *Plain People.* Many Plain People live and dress as their ancestors did and do not believe in using electricity, automobiles, telephones, or modern machinery.

King Charles II of England gave the Pennsylvania re-

The contributors of this article are Edward K. Muller, Professor of History at the University of Pittsburgh; and William C. Rense, Professor of Geography at Shippensburg University of Pennsylvania.



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owntown Pittsburgh lies between the Allegheny and
onongahela rivers. Pittsburgh is the state's second-largest city.

Interesting facts about Pennsylvania

WORLD BOOK illustrations by Kevin Chadwick

The ice cream soda was invented in Philadelphia in 1874. Robert M. Green created it at the semicentennial celebration of the Franklin Institute. According to legend, Green usually made a drink from sweet cream, syrup, and carbonated water. At the celebration, he ran out of sweet cream and substituted ice cream. The creation was so popular that his profits rose from $6 to $600 per day.

First ice cream soda

The first magazine in the American Colonies was published by Andrew Bradford of Philadelphia. *The American Magazine, or a Monthly View of the British Colonies* appeared on Feb. 13, 1741. The magazine lasted only three months.

The world's largest chocolate and confectionery factory is the Hershey Plant in Hershey. The factory, which covers 2,292,332 square feet (212,965 square meters), was established in 1905.



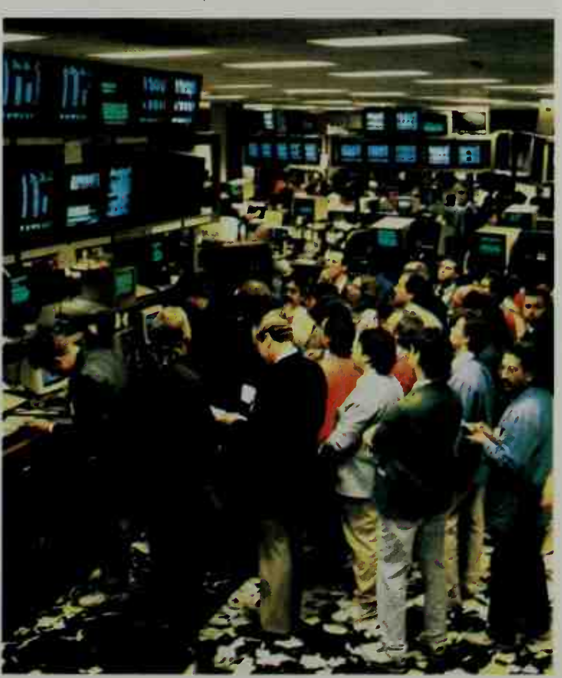
Largest chocolate factory

gion to William Penn in 1681. The word *Pennsylvania* neans *Penn's Woods.* Penn, a Quaker, established the ennsylvania colony as a place where Quakers and peo- le of other faiths could enjoy religious freedom.

The First and Second Continental Congresses met in hiladelphia before and during the Revolutionary War. n July 4, 1776, the Declaration of Independence was dopted in Pennsylvania's State House (now Independence Hall) in Philadelphia. British troops captured Philadelphia in September 1777, and held the city until June 778. General George Washington and his troops spent he winter and spring of 1777-1778 in Valley Forge orthwest of Philadelphia. Philadelphia was the site of he Constitutional Convention of 1787, and served as the ation's capital from 1790 to 1800. On Dec. 12, 1787, ennsylvania *ratified* (approved) the U.S. Constitution nd became the second state.

During the Civil War, Gettysburg, in southern Pennsylania, was the site of the historic Battle of Gettysburg July 1-3, 1863). The battle marked a turning point in the ighting. Union forces broke the strength of General obert E. Lee's Confederate Army. On Nov. 19, 1863, resident Abraham Lincoln delivered his Gettysburg Address at the battlefield, now a national military park.

Pennsylvania is nicknamed the *Keystone State* beause it was the center, or keystone, of the "arch" ormed by the original 13 American states. It is someimes called the *Quaker State* because William Penn and nany of his followers were Quakers.



Mark Garvin, Philadelphia Stock Exchange

The Philadelphia Stock Exchange is one of the largest securities exchanges in the United States. Philadelphia is a center of Pennsylvania's financial industry.

Pennsylvania in brief

Symbols of Pennsylvania

The state flag, adopted in 1907, bears the state coat of arms, which is supported by two horses. The seal, adopted in 1791, has a shield that displays a sailing ship, a plow, and sheaves of wheat. To the left of the shield is a stalk of corn, and to the right is an olive branch. An eagle serves as a crest for the seal.







State flag

State seal



Pennsylvania (brown) ranks 33rd in size among all the states and 2nd in size among the Middle Atlantic States (yellow).

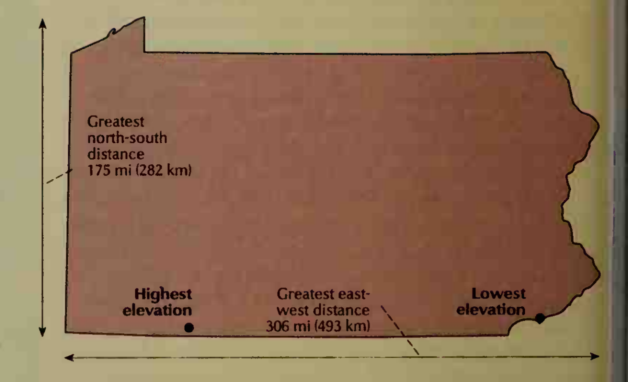
General information

Statehood: Dec. 12, 1787, the second state.
State abbreviations: Pa. or Penn. (traditional); PA (postal).
State motto: *Virtue, Liberty, and Independence.*
State song: "Pennsylvania." Words and music by Eddie Khoury and Ronnie Bonner.

The State Capitol is in Harrisburg, the capital of Pennsylvania since 1812. Earlier capitals were Chester (1681-1683), Philadelphia (1683-1799), and Lancaster (1799-1812).

Land and climate

Area: 45,310 mi^2 (117,351 km^2), including 490 mi^2 (1,269 km^2) of inland water but excluding 749 mi^2 (1,939 km^2) of Great Lakes water.
Elevation: *Highest*—Mount Davis, 3,213 ft (979 m) above sea level. *Lowest*—sea level along the Delaware River.
Record high temperature: 111° F (44 °C) at Phoenixville on July 10, 1936.
Record low temperature: −42 °F (−41 °C) at Smethport on Jan. 5, 1904.
Average July temperature: 71 °F (22 °C).
Average January temperature: 27 °F (−3 °C).
Average yearly precipitation: 41 in (104 cm).



Important dates

- **1643** Swedish settlers established Pennsylvania's first permanent European settlement on Tinicum Island.
- **1681** King Charles II of England granted the Pennsylvania region to William Penn.
- **1776** The Declaration of Independence was adopted in Philadelphia.
- **1787** Pennsylvania became the seco[illegible] state on December 12.



State game bird
Ruffed grouse



State flower
Mountain laurel



State tree
Hemlock

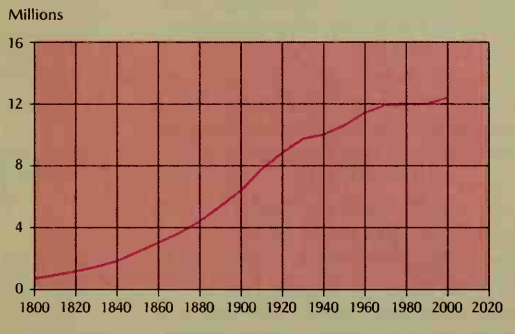
People

Population: 12,281,054 (2000 census)
Rank among the states: 6th
Density: 271 per mi² (105 per km²), U.S. average 78 per mi² (30 per km²)
Distribution*: 69 percent urban, 31 percent rural
Largest cities in Pennsylvania

City	Population
Philadelphia	1,517,560
Pittsburgh	334,563
Allentown	106,632
Erie	103,717
Upper Darby†	81,821
Reading	81,207

†Unincorporated place.
Source: 2000 census, except for *, where figures are for 1990.

Population trend



Year	Population
2000	12,281,054
1990	11,924,710
1980	11,864,751
1970	11,800,766
1960	11,319,366
1950	10,498,012
1940	9,900,180
1930	9,631,350
1920	8,720,017
1910	7,665,111
1900	6,302,115
1890	5,258,113
1880	4,282,891
1870	3,521,951
1860	2,906,215
1850	2,311,786
1840	1,724,033
1830	1,348,233
1820	1,049,458
1810	810,091
1800	602,365
1790	434,373

Source: U.S. Census Bureau.

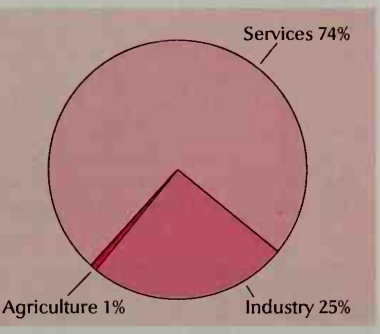
Economy

Chief products

Agriculture: milk, poultry products, greenhouse and nursery products, beef cattle, mushrooms, corn, hay.
Manufacturing: chemicals, food products, electronic equipment, fabricated metal products, machinery, primary metals, transportation equipment, paper products.
Mining: coal, natural gas, limestone.

Gross state product

Value of goods and services produced in 1998: $364,039,000,000. *Services* include community, business, and personal services; finance; government; trade; and transportation, communication, and utilities. *Industry* includes construction, manufacturing, and mining. *Agriculture* includes agriculture, fishing, and forestry.



Source: U.S. Bureau of Economic Analysis.

Government

State government

Governor: 4-year term
State senators: 50; 4-year terms
State representatives: 203; 2-year terms
Counties: 67

Federal government

United States senators: 2
United States representatives*: 21 (19)
Electoral votes*: 23 (21)

*Figures in parentheses are for January 2003 and beyond.

Sources of information

For information about tourism, write to: Pennsylvania Department of Community and Economic Development, Center for Travel, Tourism and Film, Commonwealth Keystone Building, 400 North Street, 4th Floor, Harrisburg, PA 17120. The Web site at www.experiencepa.com also provides information.
For information on the economy, write to: Pennsylvania Office of the Chief Clerk, Pennsylvania House of Representatives, House Post Office, Main Capitol Building, Harrisburg, PA 17120.
The state's Web site at www.state.pa.us provides a gateway to information on economy, government, and history.

1794 The nation's first major hard-surfaced road, between Philadelphia and Lancaster, was opened.

1859 Edwin Drake drilled the nation's first commercially successful oil well, near Titusville.

1940 The first section of the Pennsylvania Turnpike was opened.

1987 Pennsylvania marked the bicentennial of its statehood.

People

Population. The 2000 United States census reported that Pennsylvania had 12,281,054 people. The population had increased about 3 $\frac{1}{2}$ percent over the 1990 census figure, 11,881,643. According to the 2000 United States census, Pennsylvania ranks 6th in population among the 50 states.

Over four-fifths of Pennsylvania's people live in metropolitan areas (see **Metropolitan area**). The largest of these areas include Philadelphia, Pittsburgh, Allentown-Bethlehem-Easton, Harrisburg-Lebanon-Carlisle, and Scranton-Wilkes-Barre-Hazelton. For a complete list and populations of these metropolitan areas, see the *Index* to the political map of Pennsylvania.

Philadelphia is Pennsylvania's largest city, and one of the largest cities in the United States. Other large cities, in order of population, are Pittsburgh, Allentown, Erie, Reading, Scranton, and Bethlehem.

Pennsylvania's largest population groups include people of German, Irish, Italian, and English descent. About 10 percent of the people are African Americans. Other large groups include people of Polish, Slovak, and Dutch descent.

Several groups of Pennsylvanians are the descendants of Germans who came to the area in the 1600's and 1700's. They are often called *Pennsylvania Dutch*. Some of them still speak a mixture of German and English. Others speak English, but with an accent. The Pennsylvania Dutch include such religious groups as the Amish, Dunkers, and Mennonites. See **Pennsylvania Dutch**.

Schools. Most of the early teaching in Pennsylvania was controlled by churches. During the 1640's, Swedish Lutheran ministers taught in Tinicum, near what is now Essington. Pennsylvania's first colonial constitution, adopted in 1682, provided that children should know how to read and write by the age of 12. The Friends' public school, founded in Philadelphia by Quakers in 1689, still exists as the William Penn Charter School.

The state Constitution of 1790 stated that the legislature should provide schools for the children of poor parents. In 1834, the legislature passed the Free School Act. This act provided for the establishment of school districts throughout the state.

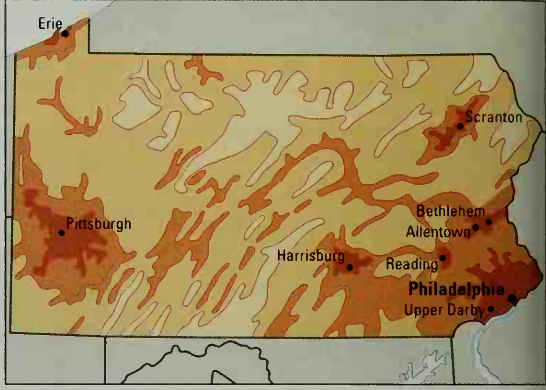
Today, each city, township, and borough in Pennsylvania has, or is part of, a school district. The state board of education, with 17 members appointed by the governor and 4 members of the legislature, establishes policies for the state's public school system. Pennsylvania's secretary of education administers the policies. A state law requires children from age 8 through 16 to attend school. For the number of students and teachers in Pennsylvania, see **Education** (table).

Libraries. Benjamin Franklin and some of his friends founded the Library Company of Philadelphia in 1731. It was the first subscription library in the American Colonies. Members contributed money to buy books for it and could then use the books without charge. In 1876, more than a hundred librarians gathered in Philadelphia for the first meeting of the American Library Association. In the late 1800's, industrialist Andrew Carnegie donated

Population density

Most of Pennsylvania's people live in the Philadelphia and Pittsburgh metropolitan areas. In mountainous central Pennsylvania, the population is scattered among valleys.





WORLD BOOK map; based on U.S. Census Bureau data.



© Al Michaud, FPG

A Philadelphia street fair attracts people to Market Street in the city's downtown area. Philadelphia is Pennsylvania's largest city and the state's chief industrial center.



© Jack A. Wol

The Amish are a Protestant group that live in Lancaster County and other parts of rural Pennsylvania. They travel in horse-drawn carriages, rejecting the use of automobiles.

ıoney to build public libraries in five communities.

Today, the state has thousands of public, school, aca-emic, and special libraries. The Free Library of Philadel-hia is the largest library. Other large libraries include ittsburgh's Carnegie Library, the University of Pennsyl-ania library, and the State Library of Pennsylvania.

Museums. The Pennsylvania Academy of the Fine rts in Philadelphia, founded in 1805, operates the na-on's oldest art museum. The Academy of Natural Sci-nces of Philadelphia is the oldest institution of natural ciences in the United States. The Academy of Natural ciences was founded in 1812.

The nation's first institute of applied sciences and me-anical arts, the Franklin Institute, opened in Philadel-hia in 1824. It houses the Fels Planetarium. The State luseum and the State Archives are in Harrisburg.

Other museums in Pennsylvania include the Mercer luseum of the Bucks County Historical Society in oylestown; Drake Well Museum in Titusville; Hershey luseum in Hershey; the Railroad Museum of Pennsyl-ania in Strasburg; the Landis Valley Museum in Lancas-r; and the Philadelphia Museum of Art and Rodin Museum, both in Philadelphia. Carnegie Museums of Pittsburgh includes the Carnegie Museum of Art, the Carnegie Museum of Natural History, the Carnegie Science Center, and the Andy Warhol Museum.



Bill West, Shostal

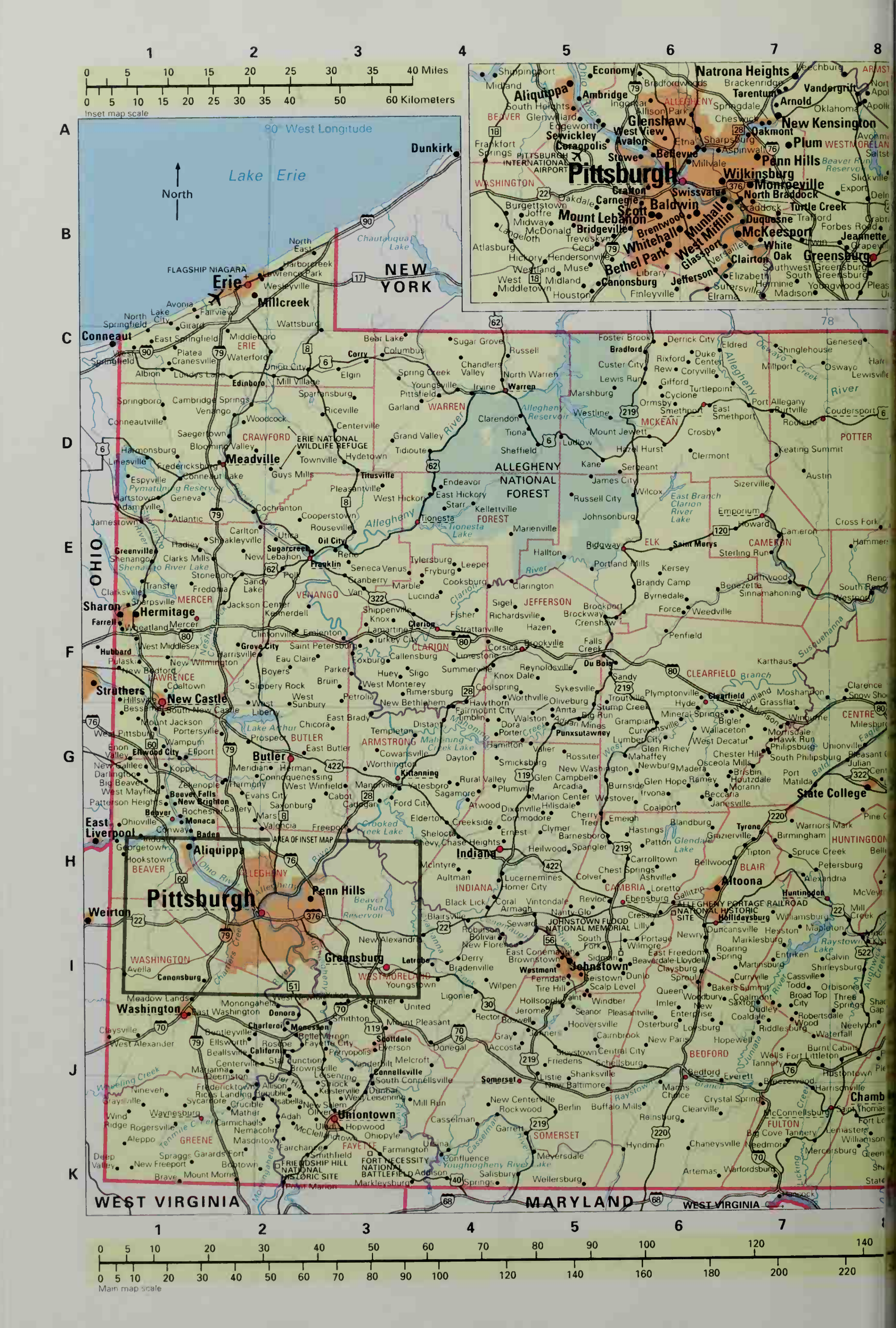
The University of Pennsylvania in Philadelphia, established in 1740, is one of the oldest institutions of higher learning in the United States. Benjamin Franklin was one of its founders.

Universities and colleges

This table lists the universities and colleges in Pennsylvania that grant bachelor's or advanced degrees and are accredited by the Middle States Association of Colleges and Schools.

Name	Mailing address
Albright College	Reading
Allegheny College	Meadville
Allentown College of St. Francis de Sales	Center Valley
Alvernia College	Reading
American College	Bryn Mawr
Arcadia University	Glenside
Arts, University of the	Philadelphia
Baptist Bible College and Seminary	Clarks Summit
Biblical Theological Seminary	Hatfield
Bloomsburg University of Pennsylvania	Bloomsburg
Bryn Athyn College of the New Church	Bryn Athyn
Bryn Mawr College	Bryn Mawr
Bucknell University	Lewisburg
Cabrini College	Radnor
California University of Pennsylvania	California
Carlow College	Pittsburgh
Carnegie Mellon University	Pittsburgh
Cedar Crest College	Allentown
Chatham College	Pittsburgh
Chestnut Hill College	Philadelphia
Cheyney University of Pennsylvania	Cheyney
Clarion University of Pennsylvania	*
College Misericordia	Dallas
Curtis Institute of Music	Philadelphia
Delaware Valley College	Doylestown
Dickinson College	Carlisle
Drexel University	Philadelphia
Duquesne University	Pittsburgh
East Stroudsburg University of Pennsylvania	East Stroudsburg
Eastern Baptist Theological Seminary	Wynnewood
Eastern College	St. Davids
Edinboro University of Pennsylvania	Edinboro
Elizabethtown College	Elizabethtown
Evangelical School of Theology	Myerstown
Franklin & Marshall College	Lancaster
Gannon University	Erie
Geneva College	Beaver Falls
Gettysburg College	Gettysburg
Gratz College	Melrose Park
Grove City College	Grove City
Gwynedd-Mercy College	Gwynedd Valley
Haverford College	Haverford
Holy Family College	Philadelphia
Immaculata College	Immaculata
Indiana University of Pennsylvania	Indiana
Juniata College	Huntingdon
Keystone College	La Plume
King's College	Wilkes-Barre
Kutztown University of Pennsylvania	Kutztown
Lafayette College	Easton
Lancaster Bible College	Lancaster
Lancaster Theological Seminary	Lancaster
La Roche College	Pittsburgh
La Salle University	Philadelphia
Lebanon Valley College	Annville
Lehigh University	Bethlehem
Lincoln University	Lincoln Univ.
Lock Haven University of Pennsylvania	Lock Haven
Lutheran Theological Seminary at Gettysburg	Gettysburg
Lutheran Theological Seminary at Philadelphia	Philadelphia
Lycoming College	Williamsport
Mansfield University of Pennsylvania	Mansfield
Marywood University	Scranton
MCP Hahnemann University	Philadelphia
Mercyhurst College	Erie
Messiah College	Grantham
Millersville University of Pennsylvania	Millersville
Moore College of Art and Design	Philadelphia
Moravian College	Bethlehem
Mount Aloysius College	Cresson
Muhlenberg College	Allentown
Neumann College	Aston
Peirce College	Philadelphia
Pennsylvania, University of	Philadelphia
Pennsylvania College of Optometry	Elkins Park
Pennsylvania College of Technology	Williamsport
Pennsylvania State University	†
Philadelphia, University of the Sciences in	Philadelphia
Philadelphia Biblical University	Langhorne
Philadelphia College of Osteopathic Medicine	Philadelphia
Philadelphia University	Philadelphia
Pittsburgh, University of	‡
Pittsburgh Theological Seminary	Pittsburgh
Point Park College	Pittsburgh
Reconstructionist Rabbinical College	Wyncote
Robert Morris College	Moon Township
Rosemont College	Rosemont
St. Charles Borromeo Seminary	Wynnewood
St. Francis University	Loretto
St. Joseph's University	Philadelphia
St. Vincent College	Latrobe
Scranton, University of	Scranton
Seton Hill College	Greensburg
Shippensburg University of Pennsylvania	Shippensburg
Slippery Rock University of Pennsylvania	Slippery Rock
Susquehanna University	Selinsgrove
Swarthmore College	Swarthmore
Temple University	Philadelphia
Thiel College	Greenville
Thomas Jefferson University	Philadelphia
Ursinus College	Collegeville
Villanova University	Villanova
Washington and Jefferson College	Washington
Waynesburg College	Waynesburg
West Chester University of Pennsylvania	West Chester
Westminster College	New Wilmington
Westminster Theological Seminary	Philadelphia
Widener University	Chester
Wilkes University	Wilkes-Barre
Wilson College	Chambersburg
York College of Pennsylvania	York

Campuses at Clarion and Oil City.
For campuses, see Pennsylvania State University.
For campuses, see Pittsburgh, University of.



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K
0 5 10 15 20 25 30 35 40 Miles
0 5 10 15 20 25 30 35 40 50 60 Kilometers
Inset map scale
80° West Longitude
Lake Erie
North
Dunkirk
NEW YORK
Chautauqua Lake
FLAGSHIP NIAGARA
North East
Harborcreek
Lawrence Park
Erie
Wesleyville
Millcreek
Avonia
Fairview
North Springfield
Lake City
Girard
Conneaut
East Springfield
West Springfield
Platea
Cranesville
Middleboro
ERIE
Waterford
Albion
Wattsburg
Union City
Corry
Columbus
Bear Lake
Sugar Grove
Russell
Elgin
Edinboro
Mill Village
Spring Creek
Chandlers Valley
North Warren
Warren
Irvine
Youngsville
Pittsfield
Spartansburg
Garland
WARREN
Springboro
Cambridge Springs
Venango
Riceville
Conneautville
Woodcock
Centerville
Saegertown
CRAWFORD
ERIE NATIONAL WILDLIFE REFUGE
Grand Valley
Tidioute
Clarendon
Tiona
Sheffield
Allegheny Reservoir
Allegheny River
Harmonsburg
Linesville
Meadville
Townville
Hydetown
Guys Mills
Conneaut Lake
Titusville
Espyville
Pymatuning Reservoir
Hartstown
Adamsville
Geneva
Pleasantville
West Hickory
Endeavor
East Hickory
Starr
Kellettville
ALLEGHENY NATIONAL FOREST
FOREST
Tionesta
Tionesta Lake
Marienville
Jamestown
Atlantic
Cochranton
Cooperstown
Rouseville
Oil City
Carlton
Utica
Sugarcreek
Hadley
Sheakleyville
Greenville
Shenango
Shenango River Lake
Clarks Mills
New Lebanon
Reno
Franklin
Seneca
Venus
Tylersburg
Fryburg
Leeper
Stoneboro
Polk
Cranberry
Marble
Cooksburg
Transfer
Fredonia
Sandy Lake
VENANGO
Lucinda
Clarington
Clarksville
Sharpsville
MERCER
Jackson Center
Sharon
Hermitage
Farrell
Wheatland
Mercer
Kennerdell
Shippenville
Knox
Sigel
JEFFERSON
Fisher
Richardsville
Brookport
Brockway
Crenshaw
Clintonville
Emlenton
Lamartine
Clarion
Strattanville
Hazen
Hubbard
West Middlesex
Grove City
Saint Petersburg
Turkey City
CLARION
Corsica
Brookville
Falls Creek
Pulaski
New Wilmington
Harrisville
Eau Claire
Foxburg
Callensburg
Limestone
Reynoldsville
Du Bois
LAWRENCE
New Bedford
Coaltown
Boyers
Parker
Huey
Sligo
Summerville
Knox Dale
Sykesville
Sandy
Struthers
Slippery Rock
Bruin
West Monterey
Rimersburg
Coolspring
Hillsville
New Castle
West Sunbury
Petrolia
New Bethlehem
Hawthorn
Worthville
Oliveburg
Bessemer
South New Castle
West Liberty
Fairmount City
Timblin
Anita
Big Run
Stump Creek
Walston
Dora
Porter
Punxsutawney
Mount Jackson
Portersville
Chicora
East Brady
Distant
Wampum
Lake Arthur
Prospect
BUTLER
Templeton
Hamilton
West Pittsburg
Ellport
Ellwood City
East Butler
ARMSTRONG
Mahoning Creek Lake
Cowansville
Dayton
Valier
Rossiter
Smicksburg
Enon Valley
New Galilee
Koppel
Butler
Meridian
Herman
Worthington
Kittanning
Darlington
Big Beaver
Zelienople
Harmony
Connoquenessing
West Winfield
Manorville
Yatesboro
Rural Valley
Plumville
Glen Campbell
West Mayfield
Beaver Falls
New Brighton
Evans City
Cabot
Sagamore
Arcadia
Patterson Heights
Rochester
Beaver
Callery
Saxonburg
Cadogan
Ford City
Atwood
Dixonville
Marion Center
Hillsdale
Ohioville
Monaca
Mars
Valencia
Elderton
Creekside
Commodore
East Liverpool
Conway
Baden
Freeport
Crooked Creek Lake
Shelocta
Chevy Chase Heights
Ernest
Clymer
Georgetown
AREA OF INSET MAP
Aliquippa
Hookstown
BEAVER
Ohio River
ALLEGHENY
Pittsburgh
Penn Hills
Beaver Run Reservoir
Indiana
Mcintyre
Aultman
INDIANA
Lucernemines
Homer City
Weirton
Coral
Black Lick
Armagh
Blairsville
New Alexandria
Greensburg
Latrobe
WESTMORELAND
Youngstown
WASHINGTON
Avella
Canonsburg
Seward
Robinson
Bolivar
New Florence
Derry
Bradenville
Wilpen
Ligonier
Meadow Lands
Washington
East Washington
Monongahela
Donora
Hunker
United
Charleroi
Monessen
Belle Vernon
Smithton
Mount Pleasant
Scottdale
Everson
Donegal
Claysville
Bentleyville
West Alexander
Ellsworth
California
Roscoe
Fayette City
Perryopolis
Beallsville
Centerville
Marianna
Brownsville
Star Junction
Vanderbilt
Melcroft
Connellsville
South Connellsville
Deemston
Fredericktown
Rices Landing
Nineveh
Graysville
Sycamore
Crucible
Mather
Waynesburg
Rogersville
Aleppo
GREENE
Carmichaels
Nemacolin
Masontown
Wind Ridge
Deep Valley
New Freeport
Spraggs
Garards Fort
Bobtown
Brave
Mount Morris
Isabella
Adah
Smock
Republic
Dunbar
Keisterville
Leisenring
West Leisenring
New Salem
Oliver
Uniontown
Hopwood
Ohiopyle
McClellandtown
Fairchance
Smithfield
FAYETTE
Farmington
FRIENDSHIP HILL NATIONAL HISTORIC SITE
FORT NECESSITY NATIONAL BATTLEFIELD
Markleysburg
Point Marion
Addison
Mill Run
Casselman
Confluence
Youghiogheny River Lake
Salisbury
Springs
Garrett
SOMERSET
Meyersdale
Wellersburg
Somerset
Listie
New Centerville
Rockwood
Berlin
Buffalo Mills
Shanksville
New Baltimore
Friedens
Sipesville
Jennerstown
Boswell
Jerome
Hollsopple
Windber
Scalp Level
Central City
Stoystown
Rector
Gray
Accosta
Tire Hill
Ferndale
Westmont
Johnstown
Geistown
Dunlo
Brownstown
East Conemaugh
Sidman
South Fork
JOHNSTOWN FLOOD NATIONAL MEMORIAL
Nanty-Glo
Vintondale
Revloc
Ebensburg
Cresson
Lilly
Portage
Wilmore
Beaverdale-Lloydell
East Freedom
Claysburg
Sproul
Queen
Imler
Woodbury
New Enterprise
Loysburg
Osterburg
Pleasantville
Hooversville
Cairnbrook
New Paris
Schellsburg
BEDFORD
Bedford
Everett
Manns Choice
Crystal Spring
Clearville
Rainsburg
Hyndman
Chaneysville
Artemas
Warfordsburg
Needmore
FULTON
Big Cove Tannery
McConnellsburg
Harrisonville
Burnt Cabins
Wells Tannery
Fort Littleton
Hustontown
Breezewood
Loretto
CAMBRIA
Colver
Chest Springs
Ashville
Carrolltown
Patton
Glendale Lake
Hastings
Barnesboro
Spangler
Heilwood
Emeigh
Cherry Tree
Blandburg
Coalport
Irvona
Westover
Burnside
Glen Hope
New Washington
Madera
Ramey
Beccaria
Janesville
Mahaffey
Newburg
Osceola Mills
Brisbin
Houtzdale
Morann
Glen Richey
Lumber City
Curwensville
Grampian
West Decatur
Wallaceton
Bigler
Chester Hill
Philipsburg
South Philipsburg
Port Matilda
State College
Mineral Springs
Clearfield
Hyde
Plymptonville
Troutville
CLEARFIELD
Grassflat
Moshannon
Winburne
Morrisdale
Hawk Run
Unionville
Julian
Karthaus
Penfield
Weedville
Force
Byrnedale
Brandy Camp
Kersey
Portland Mills
Ridgway
Hallton
ELK
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Johnsonburg
Russell City
Wilcox
Kane
James City
Sergeant
Hazel Hurst
Mount Jewett
Westline
MCKEAN
Ludlow
Marshburg
Lewis Run
Custer City
Bradford
Foster Brook
Rixford
Duke Center
Rew
Corryville
Gifford
Cyclone
Ormsby
Smethport
East Smethport
Turtlepoint
Crosby
Clermont
Derrick City
Eldred
Port Allegany
Roulette
Coudersport
POTTER
Shinglehouse
Millport
Oswayo Creek
Genesee
Oswayo
Lewisville
Keating Summit
Austin
Sizerville
East Branch Clarion River Lake
Emporium
Howard
Cameron
CAMERON
Sterling Run
Driftwood
Benezette
Sinnemahoning
Cross Fork
South Renovo
Westport
Clarence
Snow Shoe
CENTRE
Milesburg
Pleasant Gap
Tyrone
Warriors Mark
Birmingham
Grazierville
Tipton
BLAIR
Bellwood
Altoona
Spruce Creek
Petersburg
Alexandria
HUNTINGDON
Huntingdon
ALLEGHENY PORTAGE RAILROAD NATIONAL HISTORIC SITE
Hollidaysburg
Williamsburg
Duncansville
Hesston
Mapleton
Raystown Lake
Martinsburg
Roaring Spring
Entriken
Calvin
Shirleysburg
Curryville
Bakers Summit
Cassville
Todd
Orbisonia
Three Springs
Saxton
Coalmont
Broad Top City
Dudley
Coaldale
Robertsdale
Wood
Riddlesburg
Waterfall
Hopewell
Mill Creek
Mount Union
Juniata River
Susquehanna
OHIO
WEST VIRGINIA
MARYLAND
Economy
Shippingport
Midland
Aliquippa
Ambridge
Baden
South Heights
Glenwillard
Edgeworth
Sewickley
Coraopolis
Frankfort Springs
PITTSBURGH INTERNATIONAL AIRPORT
Avalon
West View
Glenshaw
Bellevue
Etna
Sharpsburg
Aspinwall
Millvale
Ingomar
Allison Park
Bradfordwoods
Brackenridge
Natrona Heights
Tarentum
Springdale
Cheswick
Oakmont
Vandergrift
Arnold
New Kensington
Plum
Penn Hills
Wilkinsburg
Monroeville
North Braddock
Turtle Creek
Swissvale
Crafton
Carnegie
Oakdale
Baldwin
Mount Lebanon
Scott
Bridgeville
Brentwood
Whitehall
Munhall
West Mifflin
Duquesne
McKeesport
Trafford
Forbes Road
Jeannette
Export
Delmont
Greensburg
White Oak
Clairton
Glassport
Bethel Park
Library
Jefferson
Elizabeth
Southwest Greensburg
South Greensburg
Youngwood
Hempfield
Madison
Sutersville
Elrama
Finleyville
Canonsburg
Houston
Muse
Westland
Hickory
Hendersonville
Cecil
McDonald
Midway
Burgettstown
Joffre
Langeloth
Atlasburg
West Middletown
Treveskyn
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0 5 10 20 30 40 50 60 70 80 90 100 120 140 160 180 200 220
Main map scale



Pennsylvania political map
Urban area
Park or other recreation area
Forest or other conservation area
State boundary
County boundary
YORK County name
State capital
County seat
City or town
Military or other federal area
Point of interest
Major airport
Railroad
Highways:
Expressway
Other road
Interstate
U.S.
Other
Lambert conformal conic projection; WORLD BOOK maps
Pottstown
Lansdale
Norristown
Philadelphia
Camden
Chester
Collingswood
Gloucester City
NEW JERSEY
INDEPENDENCE NATIONAL HISTORICAL PARK
PHILADELPHIA INTERNATIONAL AIRPORT
VALLEY FORGE NATIONAL HISTORICAL PARK
NEW YORK
NEW JERSEY
MARYLAND
DELAWARE
42° North Latitude
76°
Scranton
Wilkes-Barre
Allentown
Bethlehem
Reading
Harrisburg
Lancaster
York
Williamsport
Hazleton
Pottsville
Bloomsburg
Lebanon
Carlisle
Easton
Trenton
Wilmington
Phillipsburg
STEAMTOWN NATIONAL HISTORIC SITE
DELAWARE WATER GAP NATIONAL RECREATION AREA
UPPER DELAWARE SCENIC AND RECREATIONAL RIVER (Hancock to Port Jervis)
GETTYSBURG NATIONAL MILITARY PARK
EISENHOWER NATIONAL HISTORIC SITE
AREA OF INSET MAP
9 10 11 12 13 14 15 16
A B C D E F G H I J K
180 200 220 240 260 280 300 Miles
280 300 320 340 360 380 400 420 440 460 Kilometers

Pennsylvania map index

Metropolitan areas

Allentown-Bethlehem-Easton 637,958
Altoona 129,144
Erie 280,843
Harrisburg-Lebanon-Carlisle 629,401
Johnstown 232,621
Lancaster 470,658
Newburgh 387,669 (341,367 in N.Y.; 46,302 in Pa.)
Philadelphia 5,100,931 (3,849,647 in Pa.; 1,251,284 in N.J.)
Pittsburgh 2,358,695
Reading 373,638
Scranton-Wilkes-Barre-Hazleton 624,776
Sharon 120,293
State College 135,758
Williamsport 120,044
York 381,751

Counties

Adams 91,292 J 10
Allegheny 1,281,666 H 2
Armstrong 72,392 G 3
Beaver 181,412 H 1
Bedford 49,984 J 6
Berks 373,638 I 13
Blair 129,144 H 7
Bradford 62,761 D 11
Bucks 597,635 I 15
Butler 174,083 G 2
Cambria 152,598 H 6
Cameron 5,974 E 7
Carbon 58,802 G 14
Centre 135,758 G 8
Chester 433,501 K 14
Clarion 41,765 F 4
Clearfield 83,382 F 6
Clinton 37,914 F 8
Columbia 64,151 F 11
Crawford 90,366 D 2
Cumberland 213,674 J 9
Dauphin 251,798 I 11
Delaware 550,864 J 15
Elk 35,112 E 6
Erie 280,843 C 2
Fayette 148,644 K 3
Forest 4,946 E 4
Franklin 129,313 J 8
Fulton 14,261 K 7
Greene 40,672 K 1
Huntingdon 45,586 H 8
Indiana 89,605 H 4
Jefferson 45,932 F 5
Juniata 22,821 H 9
Lackawanna 213,295 F 14
Lancaster 470,658 K 13
Lawrence 94,643 F 1
Lebanon 120,327 H 11
Lehigh 312,090 H 14
Luzerne 319,250 F 13
Lycoming 120,044 E 10
McKean 45,936 D 6
Mercer 120,293 F 1
Mifflin 46,486 H 8
Monroe 138,687 F 15
Montgomery 750,097 I 15
Montour 18,236 G 11
Northampton 267,066 G 15
Northumberland 94,556 G 11
Perry 43,602 I 10
Philadelphia 1,517,550 J 15
Pike 46,302 E 16
Potter 18,080 D 8
Schuylkill 150,336 H 12
Snyder 37,546 H 10
Somerset 80,023 K 5
Sullivan 8,556 E 12
Susquehanna 42,238 C 14
Tioga 41,373 D 10
Union 41,624 G 10
Venango 57,565 E 3
Warren 43,863 D 4
Washington 202,897 I 1
Wayne 47,722 D 15
Westmoreland 369,993 I 3
Wyoming 28,080 E 13
York 381,751 K 12

Cities, boroughs, and other populated places

Adamstown 1,203 I 13
Akron 4,046 J 12
Albion 1,607 C 1
Alburtis 2,117 H 14
Aldan* 4,313 J 15
Aliquippa 11,734 H 1
Allentown° 106,632 H 14
Almedia*† 1,056 G 12
Altoona 49,523 H 6
Ambler 6,426 A 11
Ambridge 7,769 A 5
Annville† 4,518 I 12
Apollo 1,765 A 8
Archbald 6,220 E 14
Ardmore† 12,616 B 11
Arlington Heights*† 5,132 F 15
Arnold 5,667 A 7
Ashland 3,283 G 12
Ashley 2,866 F 13
Aspinwall 2,960 A 6
Atglen 1,217 J 13
Athens 3,415 C 11
Auburn 839 H 13
Audubon*† 6,549 A 10
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Claysburg† 1,503 I 6
Claysville 724 J 1
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East Berlin 1,365 J 10
East Brady 1,038 G 3
East Conemaugh 1,291 I 5
East Greenville 3,103 I 14
East Lansdowne* 2,586 J 15
East McKeesport* 2,343 I 2
East Norriton*† 13,211 A 10
East Petersburg 4,450 J 12
East Pittsburgh* 2,017 I 2
East Stroudsburg 9,888 G 15
East Uniontown*† 2,760 J 3
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Fairless Hills† 8,365 I 16
Fairview 220 C 1
Fairview [-Ferndale]*† 2,411 G 11
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Flemington 1,319 F 9
Folcroft* 6,978 K 15
Folsom*† 8,072 B 10
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Forest City 1,855 D 14
Forest Hills* 6,831 I 2
Forty Fort 4,579 F 13
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Franklin 7,212 E 3
Franklin Park* 11,364 H 2
Frederickburg 987 I 12
Frederickburg 1,140 D 2
Fredericktown† 1,094 J 2
Freedom* 1,763 H 1
Freeland 3,643 G 13
Freemansburg* 1,897 H 15
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Gap† 1,611 J 13
Garden View† 2,679 F 10
Geistown 2,555 I 5
Gettysburg° 7,490 K 10
Gilberton 867 G 12
Gilbertsville† 4,242 I 14
Girard 3,164 C 1
Girardville 1,742 G 12
Glassport 4,993 B 6
Glen Lyon† 1,881 F 13
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Harleysville† 8,795 I 15
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Lebanon South*† 2,145 I 1
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eadville° .....13,685 ..D 2
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edia° ....5,533 ..J 15
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eyersdale ......2,473 ..K 5
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ilesburg ....1,187 ..G 8
ilford° ....1,104 ..E 16
ll Hall ....1,568 ..F 9
llersburg ......2,562 ..H 10
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llheim ....749 ..G 9
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lroy† ....1,386 ..H 9
lton ....6,650 ..G 11
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onaca ....6,286 ..H 1
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onroeville ....29,349 ..B 7
ont Alto ....1,357 ..K 9
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oscow ....1,883 ..E 14
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Lebanon† .....33,017 ..B 6
ount Oliver* ....3,970 ..I 2
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ount Pocono ...2,742 ..F 15
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omet ....1,169 ..F 15
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Myerstown ......3,171 ..I 12
Nanticoke ....10,955 ..F 13
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Narberth* ....4,233 ..J 15
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Heights ....A 7
Nazareth ....6,023 ..G 15
Nemacolin† ......1,034 ..K 2
Nescopeck ....1,528 ..F 12
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Nether Provi-
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New Beaver* .....1,677 ..G 1
New Berlin ....838 ..G 10
New Bethlehem ..1,057 ..G 4
New Bloomfield° ....I 10
New Brighton ....6,641 ..G 1
New Britain* .....3,125 ..I 15
New Castle ......26,309 ..F 1
New Castle
Northwest*† ....1,535 ..F 1
New
Cumberland ....7,349 ..I 11
New Eagle* ....2,262 ..I 2
New Florence .....784 ..I 4
New Freedom ...3,512 ..K 11
New Holland .....5,092 ..J 13
New Hope ....2,252 ..I 16
New
Kensington ....14,701 ..A 7
New Milford ....878 ..C 14
New Oxford ......1,696 ..K 10
New
Philadelphia ....1,149 ..H 13
New Salem
[-Buffington]† .....808 ..J 2
New Stanton* ....1,906 ..I 3
New
Wilmington ....2,452 ..F 1
Newmans-
town† ....1,536 ..I 12
Newport ....1,506 ..H 10
Newtown ....2,312 ..A 12
Newville ....1,367 ..J 9
Nicholson ....713 ..D 13
Nixon*† ....1,404 ..G 2
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Vernon* ....2,107 ..J 2
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Braddock ....6,410 ..B 7
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Catasauqua* ....2,814 ..H 15
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Charleroi* ......1,409 ..J 2
North East ....4,601 ..B 3
North Irwin* ....879 ..I 3
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Pleasant
View*† ....1,355 ..H 3
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Versailles*† ...11,125 ..B 7
North Wales .....3,342 ..A 10
North York ....1,689 ..J 11
Northampton ....9,405 ..H 14
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land ....3,714 ..G 11
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Harbor-
creek*† ....8,658 ..B 2
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Norwood* ....5,985 ..J 15
Oakdale ....1,551 ..B 5
Oakland*† ....1,516 ..F 1
Oakmont ....6,911 ..A 7
Oakwood*† ......2,249 ..F 1
O'Hara*†▲ ....8,856 ..A 6
Ohioville ....3,759 ..H 1
Oil City ....11,504 ..E 3
Oklahoma ....915 ..A 8
Old Forge ....8,798 ..E 14
Olivert ....2,925 ..J 3
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Orchard Hills*† ..2,152 ..H 3
Oreland† ....5,509 ..A 11
Orwigsburg ......3,106 ..H 13
Osceola Mills ....1,249 ..G 7
Oxford ....4,315 ..K 13
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Palmerton ....5,248 ..G 14
Palmyra ....7,096 ..I 11
Palo Alto* ....1,052 ..H 12
Paoli† ....5,425 ..B 10
Paradise† ....1,028 ..J 13
Park Forest
Village*† ....8,830 ..G 8
Parkesburg ......3,373 ..J 13
Parkside* ....2,267 ..J 15
Parkville† ....6,593 ..K 10
Patton ....2,023 ..H 6
Paxtang ....1,570 ..I 11
Pen Argyl ....3,615 ..G 15
Penbrook ....3,044 ..I 11
Penn Hills† ......46,809 ..H 3
Penn Wynne*† ...5,382 ..B 10
Penndel ....2,420 ..A 12
Pennsburg ....2,732 ..I 14

Pennville*† ....1,964 ..K 10
Perkasie ....8,828 ..I 15
Perryopolis ......1,764 ..J 3
Phila-
delphia° ....1,517,550 ..J 15
Philipsburg ......3,056 ..G 7
Phoenixville ....14,788 ..A 10
Pine Grove ....2,154 ..H 12
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Mills† ....1,141 ..H 8
Pitcairn* ....3,689 ..I 3
Pittsburgh° ....334,563 ..H 2
Pittston ....8,104 ..E 13
Plains*▲ ....10,906 ..F 13
Pleasant Gap† ....1,611 ..G 8
Pleasant Hill*† ...2,301 ..I 12
Pleasant Hills* ....8,397 ..H 2
Pleasant View, see
North Vandergrift-
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Pleasantville ....211 ..J 6
Plum ....26,940 ..A 7
Plymouth ....6,507 ..F 13
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Meeting*† ......5,593 ..A 10
Plymptonville*† ..1,040 ..F 6
Pocono Pines† ...1,013 ..F 14
Point Marion .....1,333 ..K 2
Polk ....1,031 ..E 2
Port Allegany ....2,355 ..D 7
Port Carbon* .....2,019 ..H 13
Port Royal ....977 ..H 9
Port Vue* ....4,228 ..I 2
Portage ....2,837 ..I 6
Pottsgrove*† .....3,266 ..I 14
Pottstown ....21,859 ..I 14
Pottsville° ......15,549 ..H 12
Pricedale, see
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Pringle* ....991 ..F 13
Progress*† ....9,647 ..I 11
Prospect ....1,234 ..G 2
Prospect Park* ...6,594 ..J 15
Punxsutawney ...6,271 ..G 5
Quakertown .....8,931 ..I 15
Quarryville ....1,994 ..K 13
Radnor *†▲ .....30,878 ..B 10
Rankin* ....2,315 ..I 2
Reading° ....81,207 ..I 13
Reamstown*† ....3,498 ..I 13
Red Hill* ....2,196 ..I 14
Red Lion ....6,149 ..J 11
Reedsville† ....858 ..H 9
Renovo ....1,318 ..E 8
Republic [-Merrits-
town]† ....1,396 ..J 2
Reynoldsville ....2,710 ..F 5
Rheems† ....1,557 ..J 11
Richboro† ....6,678 ..A 12
Richland* ....1,508 ..I 12
Richlandtown ....1,283 ..H 15
Ridgway° ....4,591 ..E 6
Ridley Park ....7,196 ..B 10
Riegelsville ....863 ..H 15
Rimersburg ......1,051 ..F 3
Ringtown ....826 ..G 12
Riverside ....1,861 ..G 11
Roaring Spring ..2,418 ..I 6
Robesonia ....2,036 ..I 13
Robinson*‡ .....12,289 ..A 5
Rochester ....4,014 ..H 1
Rockledge* ......2,577 ..J 15
Rockwood ....954 ..J 4
Roscoe ....848 ..J 2
Rose Valley* ....944 ..J 15
Roseto ....1,653 ..G 15
Ross*†▲ ....32,551 ..A 6
Rothsville† ....3,017 ..J 12
Rouzerville† ....862 ..K 9
Royalton* ....963 ..I 11
Royersford ....4,246 ..A 9
Rural Valley ....922 ..G 4
Russellton*† ......1,530 ..H 2
Rutledge* ....860 ..J 15
Saegertown ......1,071 ..D 2
St. Clair ....3,254 ..H 12
St. Lawrence* ....1,812 ..I 13
St. Marys ....14,502 ..E 6
St. Michael
[-Sidman]† ....973 ..I 5
Saltsburg ....955 ..A 8
Sanatoga*† ....7,734 ..I 14
Sand Hill*† ....2,345 ..I 12
Sandy† ....1,687 ..F 5
Saxonburg ....1,629 ..G 3
Saxton ....803 ..I 7
Sayre ....5,813 ..C 12
Scalp Level ....851 ..I 5
Schnecksville† ...1,989 ..H 14
Schuylkill
Haven ....5,548 ..H 13
Schwenksville ...1,693 ..I 14
Scott†▲ ....17,288 ..B 6
Scottdale ....4,772 ..J 3
Scranton° ......76,415 ..E 14
Selinsgrove ......5,383 ..G 11
Sellersville ....4,564 ..I 15
Seneca† ....966 ..E 3
Sewickley ....3,902 ..A 5
Shaler*†▲ ....29,757 ..A 6
Shamokin ....8,009 ..G 11

Shamokin Dam ..1,502 ..G 11
Sharon ....16,328 ..F 1
Sharon Hill* ......5,468 ..J 15
Sharpsburg ......3,594 ..A 6
Sharpsville ....4,500 ..F 1
Sheffield† ....1,268 ..D 5
Shenandoah .....5,624 ..G 12
Shenandoah
Heights*† ....1,298 ..G 12
Shickshinny ....959 ..F 12
Shillington ....5,059 ..I 13
Shiloh*† ....10,192 ..J 11
Shinglehouse ....1,250 ..C 7
Shippensburg ...5,586 ..J 9
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Skyline View*† ...2,307 ..I 11
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Coatesville* ......997 ..J 14
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South
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South
Pottstown*† .....2,135 ..I 14
South Waverly .....987 ..C 11
South
Williamsport ...6,412 ..F 10
Southmont* ......2,262 ..I 5
Southwest
Greensburg ....2,398 ..B 8
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Speers* ....1,241 ..J 2
Spring City ....3,305 ..A 9
Spring Grove ....2,050 ..K 11
Spring Hill*† ....970 ..I 6
Spring House† ...3,290 ..A 11
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Springfield† ....23,677 ..B 10
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Stoneboro ....1,104 ..E 2
Stowe‡ ....6,706 ..A 6
Stowe† ....3,585 ..A 9
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Tarentum ....4,993 ..A 7
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Tower City ....1,396 ..H 11
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kenamon*† .....1,375 ..K 14
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Trafford ....3,236 ..B 7
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Tremont ....1,784 ..H 12
Tresckow† ....964 ..G 13
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Trooper*† ....6,061 ..J 15
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Trumbanuers-
ville ....1,059 ..I 15
Tullytown ....2,031 ..J 16
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Turtle Creek .....6,076 ..B 7
Tuscarora† ....939 ..G 13
Tyrone ....5,528 ..H 7
Union City ....3,463 ..C 2
Uniontown° ....12,422 ..J 3

Upland* ....2,977 ..J 15
Upper
Darby▲ ....81,821 ..B 11
Upper
Merion*▲ .....26,863 ..J 15
Upper Provi-
dence *▲ ......10,509 ..B 10
Upper
St. Clair*† ......20,053 ..I 2
Valley Forge ....A 10
Valley View† .....1,677 ..H 11
Vandergrift ......5,455 ..A 8
Vanport* ....H 1
Verona* ....3,124 ..H 2
Versailles ....1,724 ..B 7
Village Green-
Green
Ridge*† ....8,279 ..B 10
Wall* ....727 ..I 3
Walnutport ......2,043 ..G 14
Warminster ....A 11
Warren° ....10,259 ..D 4
Warren
South*† ....1,651 ..D 4
Washington° ...15,268 ..I 1
Waterford ....1,449 ..C 2
Watsontown .....2,255 ..F 11
Waymart ....1,429 ..D 15
Wayne
Heights*† ....1,805 ..K 9
Waynesboro .....9,614 ..K 9
Waynesburg° ....4,184 ..J 1
Weatherly ....2,612 ..G 13
Weigels-
town*† ....10,117 ..J 11
Weissport
East*† ....1,936 ..G 14
Wellsboro° ......3,328 ..D 9
Wernersville .....2,150 ..I 13
Wesleyville ......3,617 ..B 2
West
Brownsville* ....1,075 ..J 2
West Chester° ..17,861 ..J 14
West Consho-
hocken* ....1,446 ..J 14
West Easton* .....1,152 ..H 15
West Fairview ....I 10
West Goshen*† ..8,472 ..J 14
West Grove ......2,652 ..K 13
West Hazleton ...3,542 ..G 13
West
Homestead* ....2,197 ..I 2
West
Kittanning* ......1,199 ..G 3
West Lawn ....1,597 ..I 13
West
Leechburg* .....1,290 ..H 3
West Mayfield ...1,187 ..G 1
West Middlesex ...929 ..F 1
West Mifflin ....22,464 ..B 7
West Newton ....3,083 ..I 3
West
Norriton*† .....14,901 ..J 15
West Pittston .....5,072 ..E 13
West Reading* ...4,049 ..I 13
West View ....7,277 ..A 6
West
Wyoming* ......2,833 ..E 13
West York ....4,321 ..J 11
Westfield ....1,190 ..C 9
Westmont ....5,523 ..I 5
Wheatland ....748 ..F 1
Whitaker* ....1,338 ..I 2
White Haven .....1,182 ..F 14
White Oak ....8,437 ..B 7
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Wiconisco*▲ ....1,168 ..H 11
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Wilkins*▲ ....6,917 ..B 7
Wilkinsburg ....19,196 ..B 6
Williamsburg ....1,345 ..I 7
Williamsport° ..30,706 ..F 10
Williamstown ....1,433 ..H 11
Willow
Grove† ....16,234 ..A 11
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Windber ....4,395 ..I 5
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Heights*† ....1,402 ..E 3
Woodlyn*† ......10,036 ..B 10
Woodside
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Wrightsville ......2,223 ..J 11
Wyndmoor*† ....5,601 ..A 11
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Wyomissing
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Yeagertown† ....1,035 ..H 9
Yoe* ....1,022 ..J 11
York° ....40,862 ..J 11
Youngsville ......1,834 ..D 4
Youngwood .....4,138 ..C 8
Zelienople ....4,123 ..G 2

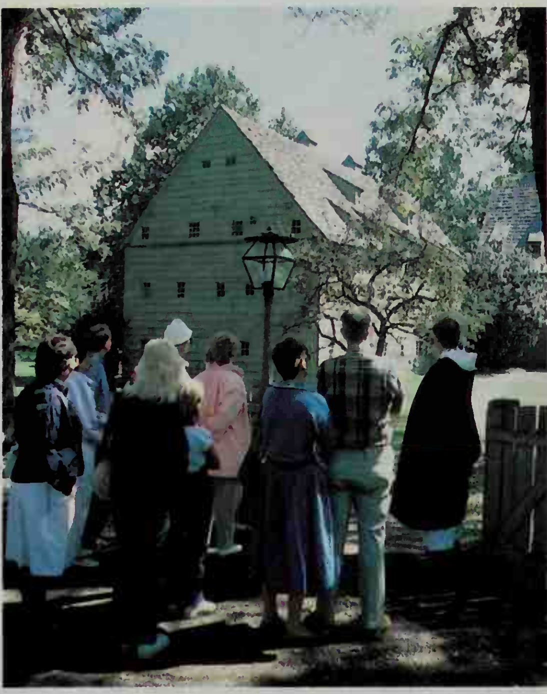
ıes not appear on the map; key shows general location.
ensus designated place—unincorporated, but recognized as a significant settled community by
U.S. Census Bureau.
ownship.

°County seat.
Places without population figures are unincorporated.
Source: 2000 census.

Visitor's guide

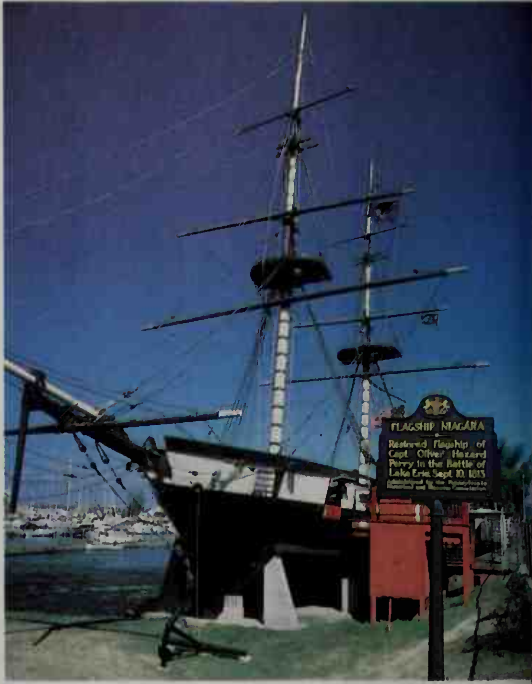
Pennsylvania's wide variety of activities and diverse experiences attract thousands of visitors each year. Vacationers can enjoy such activities as hiking, biking, fishing, white-water rafting, hunting, and skiing. They may also experience the outdoors at any of the 116 state parks scattered throughout Pennsylvania. The state is also home to more than 1,000 museums and hundreds of historical sites that help illustrate the state's rich history. Thrill seekers may want to visit one of the 20 amusement parks in the state.

One of Pennsylvania's most popular annual events is the Mummers' Parade, held on New Year's Day in Philadelphia. People celebrate the New Year by dressing in costumes and marching through the streets.



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Cloisters in Ephrata



© Ray F. Hillstrom

Oliver Perry's flagship in Erie

Places to visit

Following are brief descriptions of some of Pennsylvania's many interesting places to visit:

Ephrata Cloisters, in Ephrata, is a restored religious community built by German Seventh-Day Baptists in 1732. During the summer months, the famous Ephrata choir sings and a historical pageant is presented.

Fallingwater, near Uniontown, is one of American architect Frank Lloyd Wright's most acclaimed works. The home, which was completed in the 1930's, was built over a natural waterfall.

Flagship ***Niagara,*** restored in Erie, is the ship of Oliver Hazard Perry, who defeated the British navy on the Great Lakes during the War of 1812.

Hawk Mountain Bird Sanctuary, in the Kittatinny Mountains, is one of the world's few refuges for birds of prey.

Philadelphia, the birthplace of the United States, was the nation's capital during most of the Revolutionary War. Visitors can see many historic sites at Independence National Historical Park. The U.S. Mint conducts four tours daily. See **Philadelphia** (The city).

Pittsburgh offers visitors many attractions that reflect the city's rich history and industrial heritage. Tourists can visit Point State Park, which was once the site of Fort Dusquesne and Fort Pitt. Mount Washington, a hill that overlooks downtown Pittsburgh, features spectacular views of the city.

Steamtown National Historic Site, in Scranton, is the only site in the National Park System dedicated to steam railroading. The park's history museum includes displays on early railroads, life on the railroad, and the relationship between railroads, business, and government.

Parklands in Pennsylvania are among the state's most interesting tourist attractions. Gettysburg National Military Park was the scene of the historic Battle of Gettysburg during the Civil War. There, on Nov. 19, 1863, Abraham Lincoln delivered his famous Gettysburg Address. Independence National Historical Park in Philadelphia features such fascinating landmarks as Independence Hall, Congress Hall, and many other historic places. For more information about these and other parklands that the National Park Service administers in Pennsylvania, see the map and tables in the *World Book* article on **National Park System.**

National forest. Allegheny National Forest is located in northwestern Pennsylvania. It covers 510,536 acres (206,607 hectares).

State parks and forests. Pennsylvania has 116 state parks, 5 historical parks, 44 natural areas, 13 wild areas, and about 30 state forest picnic areas. For information on the state parks of Pennsylvania, write to Pennsylvania Department of Environmental Resources, Bureau of State Parks, Market Street State Office Building, Harrisburg, PA 17105.

Gettysburg Travel Council

Civil War Heritage Days in Gettysburg



Walter M. Faust Photographers

The Liberty Bell in Philadelphia

Annual events

January-March
Pennsylvania Cross-Country Sled Dog Championship in Marshburg (January); Pennsylvania Farm Show in Harrisburg (second week in January); Pottsville Winter Carnival (late January); U.S. Pro Indoor Tennis Championship in Philadelphia (February); Ground-hog Day Festivities in Punxsutawney (early February); Philadelphia Boat Show (January); Greenburg's Great Train, Dollhouse, and Toy Show in Pittsburgh (February); Philadelphia Flower Show (March); Charter Day, honoring the granting of Pennsylvania's charter to William Penn, statewide (March); Pennsylvania National Arts and Crafts Show in Harrisburg (late March); American Music Theatre Festival in Philadelphia (late March to late June).

April-July
Pennsylvania Maple Festival in Meyersdale (April); Cherry Blossom Festival in Wilkes-Barre (late April); Bach Music Festival in Bethlehem (second and third weekends in May); Philadelphia Festival of World Cinema (May); National Pike Festival in Washington County (mid-May); Pittsburgh Folk Festival (late May); Armed Forces Airshow in Avoca (June); Three Rivers Arts Festival in Pittsburgh (early to mid-June); Scottish Games and County Fair in Devon (mid-June); Pennsylvania State Laurel Festival in Wellsboro (mid-June); Civil War Heritage Days in Gettysburg (late June); Pennsylvania Renaissance Faire in Cornwall (July to mid-October, weekends); Freedom Festival in Philadelphia (early July); Bark Peeler's Convention near Galeton (early July); Central Pennsylvania Festival of the Arts in State College (mid-July); Kunstfest in Ambridge (mid-July); Bavarian Beer Fest in Adamstown (mid-July to early September, weekends).

August-September
Woodsmen's Show near Galeton (August); Pittsburgh Three Rivers Regatta (early August); Kutztown Fair (August); Musikfest in Bethlehem (August); Little League Baseball World Series in South Williamsport (late August); Ligonier Highland Games (early September); Bean Soup Festival in McClure (mid-September).

October-December
Fall Meet of the Antique Auto Club of America in Hershey (early October); Pennsylvania National Horse Show in Harrisburg (late October); Chrysanthemum Festival in Kennett Square (November); Reenactment of Washington Crossing the Delaware at Washington Crossing Historic Park (December 25).

© Art Wilkinson, FPG



New Year's Day Mummers' Parade in Philadelphia

Land regions. During the Pleistocene Epoch, which ended about 11,500 years ago, glaciers spread into what is now northern Pennsylvania. They formed some of the state's striking natural features.

Pennsylvania has seven main land regions: (1) the Erie Lowland, (2) the Appalachian Plateau, (3) the Appalachian Ridge and Valley Region, (4) the Blue Ridge, (5) the Piedmont, (6) the New England Upland, and (7) the Atlantic Coastal Plain.

The Erie Lowland covers parts of Pennsylvania and New York. It is a narrow strip in the northwestern corner of Pennsylvania, on Lake Erie's shores. The region's flatland was once part of the lake bed. Vegetables and fruits, especially grapes, thrive in its sandy soil.

The Appalachian Plateau extends from New York to Alabama. In Pennsylvania, it is also called the *Allegheny Plateau.* It covers the entire northern and western portions of Pennsylvania, except for the narrow Erie Lowland region. The Appalachian Plateau consists of deep, narrow valleys and broad-topped plateaulike *divides* (land ridges from which rivers flow in opposite directions). Glacial rocks and boulders dot the northern part of the region. Plateaus rise 2,000 feet (610 meters) or more in the north-central section, and slope gradually to the east, west, and southwest. The Allegheny Mountains, at the plateau's eastern edge, extend from north-central Pennsylvania to West Virginia and Virginia. Chestnut Ridge and Laurel Hill, in southwestern Pennsylvania, form some of the higher and more rugged parts of the region. Mount Davis, the state's highest point, rises 3,213 feet (979 meters) in Somerset County near the southern boundary. The western Appalachian Plateau has many coal, gas, and oil fields. The Pocono Mountains are in the northeastern part of the plateau.

The Appalachian Ridge and Valley Region extends from New York to Alabama. In Pennsylvania, it forms a wide strip of land that curves south and east of the Appalachian Plateau. The area where the ridge and valley region and the plateau meet is called the *Allegheny Front.* It forms a large physical barrier.

An area called the Great Valley sweeps along the southern and eastern boundary of Pennsylvania's ridge and valley region. The Great Valley is divided into the Cumberland, Lebanon, and Lehigh valleys. All these valleys have fertile farmland. North and west of the Great Valley, the region consists of a series of long, parallel ridges and valleys that curve from southwest to northeast. The ridges include Blue, Jacks, and Tuscarora mountains, which belong to the Appalachian Mountain system. The ridges consist of folded layers of *sedimentary rock* (rock formed from deposits laid down by ancient rivers and lakes). Erosion has worn down the softer rock layers, forming the valleys. The Delaware Water Gap opens through the Kittatinny Mountains along the Pennsylvania-New Jersey boundary. Hard-coal fields and slate formations are in the eastern part of the region.

The Blue Ridge, named for the Blue Ridge Mountains stretches from southern Pennsylvania to Georgia. In Pennsylvania, it forms a narrow, finger-shaped region at the state's south-central border. Beautiful South Mountain, scenic Buchanan Valley, and part of Gettysburg National Military Park are in this region.

The Piedmont extends from New Jersey to Alabama. In Pennsylvania, it covers most of the southeastern part of the state. The region has rolling plains, and low hills with irregular ridges and fertile valleys. The Pennsylvania Dutch areas of Lancaster and York counties have some of the richest farmland in the United States.

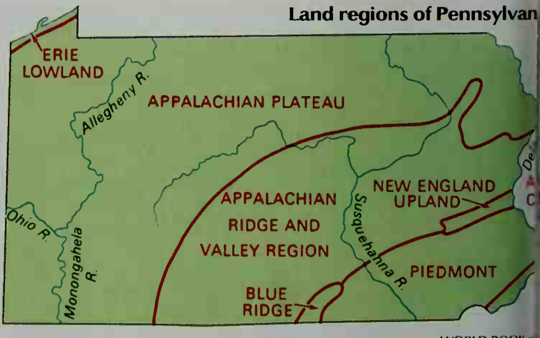
The New England Upland extends from Pennsylvania to Maine. In Pennsylvania, it forms a narrow rectangular ridge in the eastern section. The ridge crosses portions



© Jeff Gnass, West Stock

The Delaware Water Gap is a popular resort area along the Pennsylvania-New Jersey border. The Delaware River cut the gap through the Kittatinny Mountains millions of years ago.

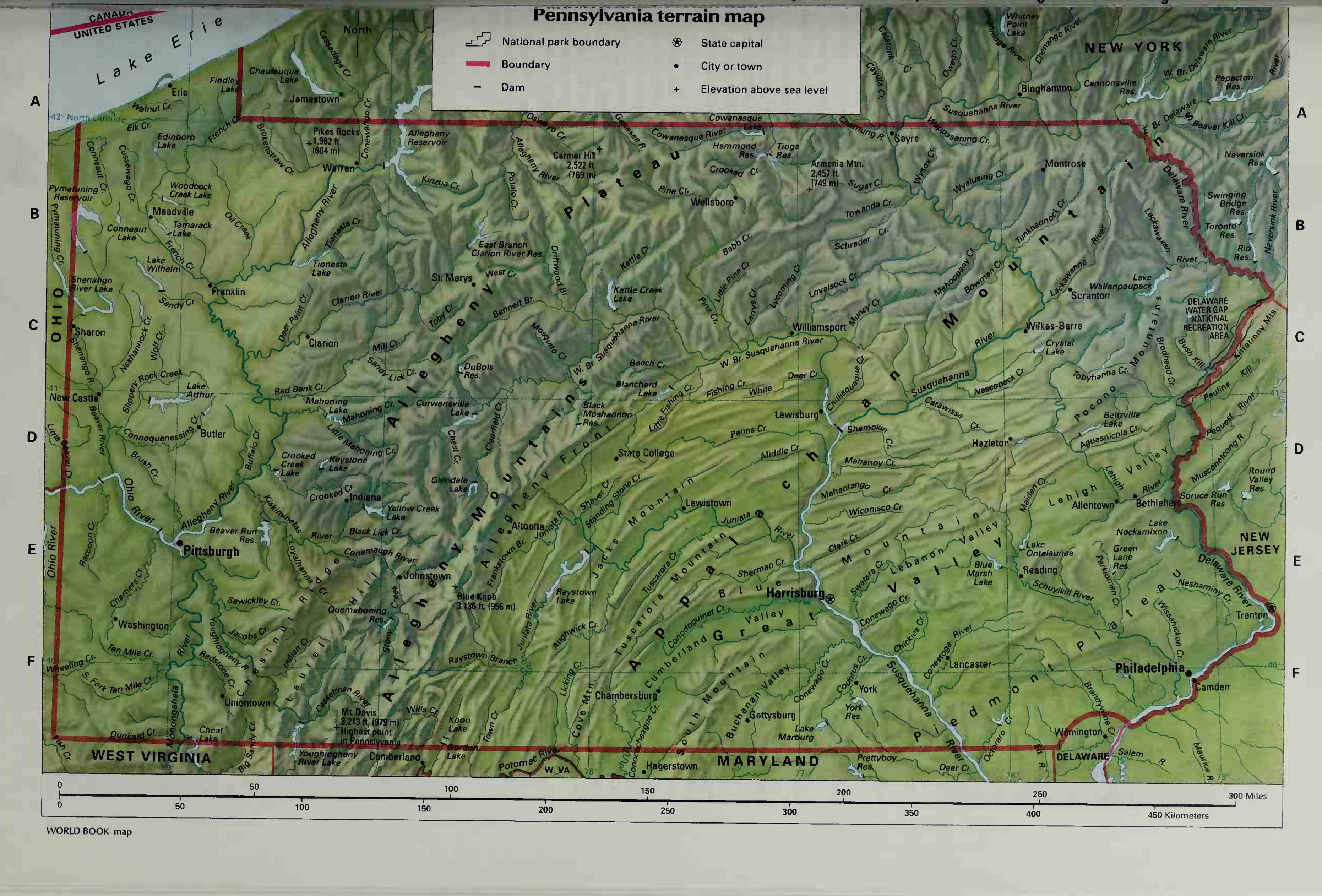
Land regions of Pennsylvan



WORLD BOOK

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Pikes Rocks (mtn.)	A	2
Pine Creek	C	5
Pocono Mountains	C	9
Pymatuning Reservoir	B	1
Raystown Branch	F	
Raystown Lake	E	
Schuylkill River	E	
Shenango River Lake	C	
South Mountain	F	
Susquehanna River	C	
Tionesta Creek	B	
Tionesta Lake	B	
Tuscarora Mountain	E	
Youghiogheny River	F	



Pennsylvania terrain map
National park boundary
Boundary
Dam
State capital
City or town
Elevation above sea level
North
Lake Erie
CANADA
UNITED STATES
NEW YORK
NEW JERSEY
DELAWARE
MARYLAND
WEST VIRGINIA
W. VA.
OHIO
Allegheny Plateau
Pocono Mountains
Allegheny Mountains
Allegheny Front
Appalachian Ridge and Valley
Blue Mountain
Great Valley
Piedmont
Laurel Hill
Chestnut Ridge
Tuscarora Mountain
Jacks Mountain
South Mountain
Cove Mtn
Lebanon Valley
Cumberland Valley
Kittatinny Mts.
DELAWARE WATER GAP NATIONAL RECREATION AREA
Erie
Jamestown
Warren
Meadville
Franklin
Sharon
New Castle
Butler
Clarion
St. Marys
Wellsboro
Sayre
Binghamton
Montrose
Scranton
Wilkes-Barre
Williamsport
Lewisburg
Hazleton
State College
Lewistown
Altoona
Johnstown
Indiana
Pittsburgh
Washington
Uniontown
Cumberland
Hagerstown
Chambersburg
Gettysburg
Harrisburg
York
Lancaster
Reading
Allentown
Bethlehem
Trenton
Philadelphia
Camden
Wilmington
Salem
Pikes Rocks 1,982 ft. (604 m)
Carmer Hill 2,522 ft. (769 m)
Armenia Mtn. 2,457 ft. (749 m)
Blue Knob 3,136 ft. (956 m)
Mt. Davis 3,213 ft. (979 m) Highest point in Pennsylvania
Delaware River
Susquehanna River
W. Br. Susquehanna River
Allegheny River
Ohio River
Monongahela River
Youghiogheny River
Juniata River
Schuylkill River
Lehigh River
Lackawaxen River
Clarion River
Conemaugh River
Kiskiminetas River
Beaver River
Allegheny Reservoir
Pymatuning Reservoir
Raystown Lake
Lake Wallenpaupack
42° North Latitude
0 50 100 150 200 250 300 Miles
0 50 100 150 200 250 300 350 400 450 Kilometers
WORLD BOOK map



© Jack A. Wolf

The Appalachian Plateau, also called the Allegheny Plateau, covers most of northern and western Pennsylvania. This rugged region consists of broad ridges and deep, narrow valleys.

of Berks, Bucks, Lehigh, and Northampton counties.

The Atlantic Coastal Plain stretches from New York to southern Florida. In Pennsylvania, it is a narrow strip of land that crosses the southeastern corner. The region is low, level, and fertile. It drops to sea level along the Delaware River. Philadelphia is near the region's center.

Rivers, waterfalls, and lakes. Eastern and central Pennsylvania are drained by the Delaware, Juniata, Lehigh, Schuylkill, and Susquehanna rivers. The Ohio River system drains western Pennsylvania. The Ohio begins where the Allegheny and Monongahela rivers meet at Pittsburgh. The waters that form or feed the Ohio River include the Allegheny, Monongahela, Beaver, Conemaugh, and Youghiogheny rivers. The Ohio flows to the Gulf of Mexico by way of the Mississippi River.

Some of the most spectacular waterfalls in the Eastern United States plunge over cliffs in the Pocono Mountains. Falls include Bushkill, Raymondskill, and Winona falls. Other waterfalls in the state are Beaver, Buttermilk, Dingmans, and Silver Thread.

Lake Conneaut is the largest natural lake entirely within Pennsylvania. It covers about 1 $\frac{1}{2}$ square miles (3.9 square kilometers) in the northwestern section. The largest body of water in the state is artificially created Raystown Lake. It covers 13 square miles (34 square kilometers) in southwestern Pennsylvania. Pymatuning Reservoir covers almost 26 square miles (67 square kilometers). It extends into Ohio. Many glacial lakes dot the northeastern Appalachian Plateau. Lake Erie touches the northwestern corner of Pennsylvania.

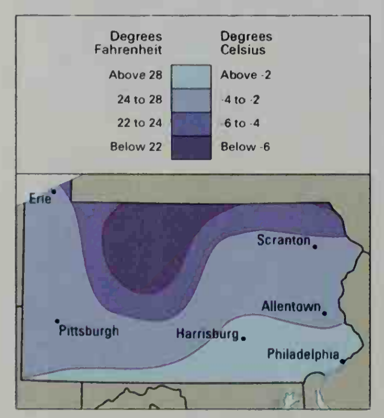
Plant and animal life. Forests cover about three-fifths of Pennsylvania. Mixtures of hardwood and softwood trees are found in the north and on the higher ridges in the south. They consist mainly of beeches, birches, hemlocks, maples, and pines. Hardwoods, including hickories, oaks, and walnuts, grow chiefly in the lowland sections of the southeast and southwest. These trees may also be found in some of the northern valleys of the Appalachian Ridge and Valley Region. Other common trees include the ash, aspen, basswood, black cherry, sycamore, and yellow-poplar.

Rhododendrons, wild azaleas, wild berries, wild ginger, and wintergreen grow throughout Pennsylvania. Shrubbery of mountain laurel, the state flower, spreads over much of the countryside. Colorful clusters of bouncing Bet, hound's-tongue, milkweed, sundew, and viper's bugloss brighten the riverbanks. Greenbriers and ferns grow in the western valleys. Common spring flowers include the anemone, bloodroot, dog-tooth violet, hepatica, and wild honeysuckle.

Animal life includes deer, moles, muskrats, opossums, rabbits, raccoons, skunks, snakes, and squirrels. Black bears, the state's most prized game animals, roam the mountains and wooded areas of northern Pennsylvania. The ruffed grouse, the state bird, feeds along woodland streams. Wild turkeys live in some parts of the state. Other common game birds include gray partridges and ring-necked pheasants. Fishes in the lakes, rivers, and streams include bass, brown trout, carp, chubs, and pickerels. Pennsylvania has some of the best-known trout streams for fly-fishing in the eastern United States.

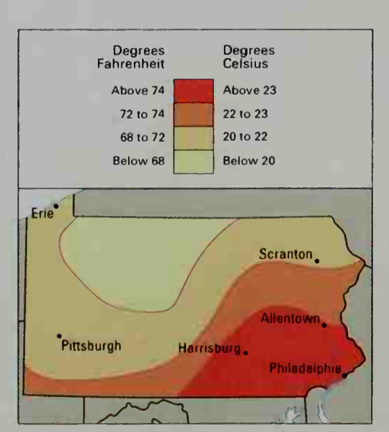
Average January temperatures

Pennsylvania has a cold winter climate. The north has the lowest temperatures. The southeast has the mildest winters.



Average July temperatures

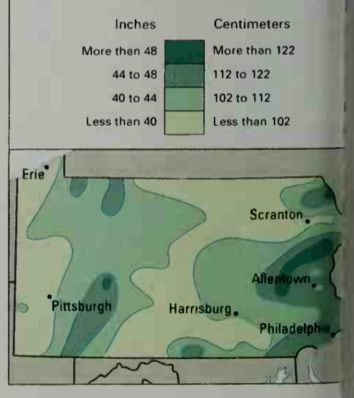
The southeastern part of Pennsylvania has the warmest summers. Temperatures increasingly decline to the northwest.



Average yearly precipitation

Precipitation varies widely throughout the state. The central and western sections of Pennsylvania are the driest.





\verage monthly weather

	Philadelphia					Pittsburgh				
	Temperatures °F		°C		Days of rain or snow		Temperatures °F		°C		Days of rain or snow
	High	Low	High	Low			High	Low	High	Low	

	°F High	°F Low	°C High	°C Low	Days of rain or snow		°F High	°F Low	°C High	°C Low	Days of rain or snow
Ian.	41	25	5	−4	12	Jan.	37	21	3	−6	16
⁻eb.	42	25	6	−4	9	Feb.	38	21	3	−6	14
Mar.	52	33	11	1	12	Mar.	48	29	9	−2	16
\pr.	62	41	17	5	11	Apr.	59	38	15	3	15
May	74	52	23	11	12	May	71	49	22	9	11
une	83	62	28	17	11	June	79	58	26	14	12
uly	87	66	31	19	9	July	83	62	28	17	10
\ug.	84	64	29	18	9	Aug.	81	59	27	15	9
;ept.	78	58	26	14	8	Sept.	75	55	24	13	7
Oct.	67	46	19	8	8	Oct.	63	43	17	6	11
Nov.	55	37	13	3	9	Nov.	49	33	9	1	12
Dec.	44	27	7	−3	10	Dec.	38	24	3	−4	16

Climate. Pennsylvania has a moist climate with cold winters and warm summers. Northern and western Pennsylvania are generally colder than the southern and eastern parts. January temperatures average 26 °F (−3.3 °C) in the north, 27 °F (−2.8 °C) in the Erie Lowland, and 34 °F (1 °C) in the southeast. Average July temperatures range from 70 °F (21 °C) in the northwest to 75 °F (24 °C) in the southwest and 77 °F (25 °C) in the southeast. Pennsylvania's record low temperature, −42 °F (−41 °C), occurred in Smethport in McKean County on Jan. 5, 1904. Phoenixville, in southeastern Pennsylvania, had the record high, 111 °F (44 °C), on July 10, 1936.

The state's yearly *precipitation* (rain, melted snow, and other forms of moisture) averages about 41 inches (104 centimeters). The northwest has 34 to 44 inches (86 to 112 centimeters) a year. The southeast has 42 to 47 inches (107 to 119 centimeters). Snowfall averages from 20 inches (51 centimeters) in southeastern Pennsylvania to 90 inches (230 centimeters) in the northwestern part of the state.

Economy

Until the 1970's, Pennsylvania's economy relied heavily n manufacturing steel and machinery. Factories in most arts of the state made these products. Pennsylvania still anks among the leading producers of steel and machin-y, but these items are now much less important to the conomy. The leading manufactured goods in the state e now chemicals, food products, and computer com-onents. The Philadelphia and Pittsburgh areas are ennsylvania's leading manufacturing centers. Other im-ortant manufacturing cities in Pennsylvania include Al-ntown, Bethlehem, Erie, Harrisburg, Lancaster, Read-g, Scranton, Wilkes-Barre, Williamsport, and York.

Despite Pennsylvania's importance as a manufacturing ate, service industries make up the largest part of the conomy. Such activities as banking, health care, and re-il trade have grown rapidly in importance since the 70's. Service industries provide jobs for about three-urths of Pennsylvania's workers. Several of the service dustries benefit from tourism. Tourism is especially nportant in Philadelphia, along Lake Erie, in the Pocono ountains, and in the Pennsylvania Dutch area.

Agriculture and mining each contribute only a small ortion of Pennsylvania's gross state product. Milk is the ate's leading agricultural product. Dairy farms can be und throughout the state. Coal is Pennsylvania's most portant mined product. Western Pennsylvania pro-ices large amounts of bituminous coal from both sur-e and underground mines. Mines in the eastern part the state provide all of the nation's *anthracite* (hard al).

Natural resources of Pennsylvania include rich soils, eat mineral wealth, good water supplies, and plentiful nber

Soil. Pennsylvania has many kinds of soil. Much of the edmont, the New England Upland, and the Atlantic astal Plain regions are covered with well-drained, ay-brown to reddish-brown soils. These are some of e most fertile soils in the eastern United States. Rich ale and limestone soils cover the valleys of the Ap-achian Ridge and Valley Region. Stony soils cover much of the hard, sandstone-capped ridges. Gravelly and sandy loams, formed by glacial lake deposits, cover the Erie Lowland in extreme northwestern Pennsylvania. Infertile sandstone and shale soils cover much of the Appalachian Plateau.

Minerals. Large deposits of anthracite occur in Lackawanna, Luzerne, Schuylkill, and other counties in eastern Pennsylvania. The western part of the state has huge deposits of *bituminous* (soft) coal. Deposits of dolomite, limestone, sandstone, and shale are also common. Most of the western counties of the state have natural gas and petroleum fields. Deposits of iron ore lie near Reading. Other mined products found in Pennsylvania include clays; mica; peat; slate; and *tripoli,* a kind of silica.

Service industries taken together account for the largest portion of Pennsylvania's gross state product.

Production and workers by economic activities

Economic activities	Percent of GSP* produced	Employed workers: Number of people	Employed workers: Percent of total
Community, business, & personal services	22	2,255,300	33
Manufacturing	20	976,600	15
Finance, insurance, & real estate	18	511,600	8
Wholesale & retail trade	15	1,446,800	21
Government	10	758,300	11
Transportation, communication, & utilities	9	330,900	5
Construction	4	350,000	5
Agriculture	1	142,000	2
Mining	1	27,800	†
Total	100	6,799,300	100

*GSP = gross state product, the total value of goods and services produced in a year.
†Less than one-half of one percent.
Figures are for 1998.
Sources: *World Book* estimates based on data from U.S. Bureau of Economic Analysis and U.S. Bureau of Labor Statistics.



The Port of Philadelphia ranks among the leading ports in the United States. Oceangoing ships reach the port by way of the Delaware River.

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Most of the service industries are located in the Philadelphia and Pittsburgh metropolitan areas.

Community, business, and personal services form Pennsylvania's leading service industry in terms of the gross state product. This industry employs more people than any other industry in the state. It includes businesses such as hotels, professional sports franchises, private health care, and engineering and law firms. Philadelphia is home to some of the nation's leading law firms. Pittsburgh has many engineering firms.

Finance, insurance, and real estate form the second-ranking service industry in Pennsylvania in terms of the gross state product. The Philadelphia and Pittsburgh areas are important national financial centers. Several large holding companies and banks have headquarters located in the two areas. Philadelphia has a major stock exchange. Real estate is important to Pennsylvania because of the large amounts of money involved in the buying and selling of properties.

Ranking next among Pennsylvania's service industries is wholesale and retail trade. The wholesale trade of automobiles, coal, groceries, industrial machinery, and petroleum is especially important. The Port of Philadelphia handles large quantities of imported petroleum. Major types of retail trade establishments include automobile dealerships, department stores, grocery stores, and restaurants.

Government ranks fourth among the service industries. Government services include the operation of public schools and hospitals, and military activities.

Transportation, communication, and utilities form the state's fifth-ranking service industry. More information about transportation and communication appears later in this section.

Manufacturing. Goods manufactured in Pennsylvania have a *value added by manufacture* of about $90 billion yearly. Value added by manufacture represents the increase in value of raw materials after they become finished products. Pennsylvania is among the top manufacturing states. Many types of manufactured products

© John Launois, Black Star



Steelmaking is a major industry in several Pennsylvania cities. Pennsylvania ranks among the leading U.S. states in the production of steel.

nake important contributions to the state's economy.

Chemicals are Pennsylvania's leading manufactured ›roduct in terms of value added by manufacture. Phar- naceuticals are the most important part of the state's :hemical industry. One of world's largest producers of ›rescription drugs is based in Philadelphia. A leading .spirin producer has operations in Pittsburgh. Other hemicals manufactured in Pennsylvania include paint, ›etrochemicals, and synthetic resins.

Processed foods and beverages rank second among 'ennsylvania's manufactured goods. The leading prod- cts include beer, bread and cakes, chocolate and co- oa products, cookies and crackers, and sausages and ›repared meats. Pennsylvania is a leading food-process- ıg state. It leads the United States in mushroom can- ing, and ranks among the leaders in the manufacture of :e cream, potato chips, and pretzels. Hershey Foods, /hich was founded in Pennsylvania, operates the largest hocolate and cocoa factory in the world. The Philadel- hia area is the state's principal food-processing center.

Ranking third among the state's manufactured prod- cts is computer and electronic equipment. The leading roducts in this sector include semiconductors and oth- r electronic components, scientific instruments for in- ustry, and communications equipment. The suburban reas of Philadelphia and Pittsburgh are the leading re- ions for the manufacture of electronic equipment.

Fabricated metal products rank next among the state's ıanufactured products. Sheet metal, metal plate, and ther structural metal products are the chief fabricated ıetal products. Industrial machinery is the fifth-ranking ıanufactured product. The Philadelphia and Pittsburgh 'eas are the main machinery manufacturing centers.

Other manufactured products of Pennsylvania include rimary metals, transportation equipment, paper prod- :ts, and printed materials. Steel is, by far, the leading rimary metal produced in the state. Types of trans- ›rtation equipment made in Pennsylvania include air- 'aft, motor vehicles, and railroad cars. Paper mills oper- e in many counties throughout the state. Commercial 'int shops and newspaper, book, and magazine pub- ;hers turn out most of Pennsylvania's printed materials.

Pennsylvania ranks among the leading states in making clothing and textiles, glass products, plastics products, and refined petroleum. The Philadelphia and Allentown-Easton areas are the major producers of clothing and textiles. One of the world's largest glass companies is based in Pittsburgh. The state's many plastics products include plastic bags, pipes, and bottles. Marcus Hook and Philadelphia have large oil refineries.

Agriculture. Farmland covers about a third of Pennsylvania's land area. The state has about 60,000 farms.

Livestock and livestock products earn about two-thirds of Pennsylvania's total farm income. Milk is the state's leading agricultural product. Pennsylvania is among the leading states in milk production. Dairy farming flourishes in eastern Pennsylvania. Poultry products and beef cattle rank next in value among the state's livestock products. The southeastern part of the state has many poultry farms, and Pennsylvania ranks among the leading egg-producing states. Cattle graze on the rolling hills of the southwest and in valleys along the Susquehanna River in the southeastern part of the state. Pennsylvania farmers also raise hogs and turkeys.

Crops account for about one-third of the state's farm income. Mushrooms are the leading crop, and the state ranks first in mushroom production. Most of the mushrooms are grown in southeastern Pennsylvania in special houses that are damp and cool. Corn and hay are the chief field crops. The Piedmont region leads in corn and hay production. Much of the corn and hay is used to feed beef and dairy cattle. Other important field crops include oats, potatoes, soybeans, tomatoes, and wheat.

Greenhouse and nursery products are another important source of agricultural income in Pennsylvania. They include cut flowers, house plants, and ornamental shrubs. The leading fruit crops are apples and peaches. They are grown in southern Pennsylvania. Cherries, grapes, and strawberries are also grown in the state.

Mining. Pennsylvania ranks among the leading states in coal production. The state's eastern counties mine about 5 million tons (4 $\frac{1}{2}$ million metric tons) of anthracite yearly. No other state mines anthracite. The western counties and other parts of Pennsylvania mine

:onomy of ennsylvania

ıis map shows the econom- uses of land in Pennsylvania d where the leading farm d mineral products are pro- ıced. The major urban ar- s, shown on the map in red, e important manufacturing nters.

Mostly cropland

Woodland mixed with grazing and cropland

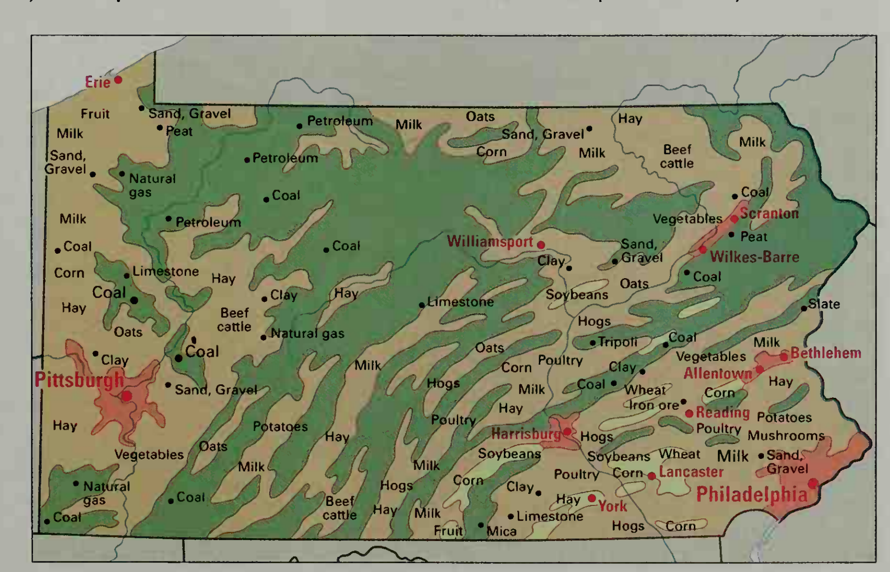
Mostly forest land

Urban area

Manufacturing center

Mineral deposit

RLD BOOK map



about 75 million tons (68 million metric tons) of bituminous coal a year. This type of coal is used to make coke and generate electric power.

Among Pennsylvania's other mined products, limestone and natural gas are most important. Limestone is used to make cement and roadbeds. Western Pennsylvania provides almost all of the state's natural gas. Pennsylvania's other mined products include sand and gravel, and petroleum.

Electric power. About 60 percent of Pennsylvania's electric power is produced by plants that burn coal. Nuclear power plants provide about 35 percent of the power. Plants that burn petroleum produce most of the rest. Pennsylvania sells some of its power to nearby states.

Beginning in 1999, Pennsylvania's electric utilities were *deregulated.* Deregulation allows customers to choose their electricity provider. Competition among utilities should result in lower electricity costs.

Transportation. Pennsylvania has been a transportation leader since colonial times. One famous early road, Queen's Road, linked Philadelphia and Chester. It was completed in 1706. The Old York Road was built between Philadelphia and New York City in the early 1700's. The nation's first major hard-surfaced road was opened between Philadelphia and Lancaster in 1794. The Pennsylvania Railroad was chartered in 1846. The first section of the Pennsylvania Turnpike, between Middlesex and Irwin, was completed in 1940. The turnpike was later extended east to New Jersey, west to Ohio, and north from Philadelphia to Scranton. East-west and north-south interstate highways were built in the 1960's and 1970's. Carlisle is a major trucking center.

Philadelphia and Pittsburgh both have major international airports. Harrisburg also has an international air terminal.

Many Pennsylvania communities are served by water transportation. Pittsburgh is the center of the state's inland waterway system. From Pittsburgh, boats can travel about 980 miles (1,580 kilometers) on the Ohio River, 130 miles (210 kilometers) on the Monongahela, and 70 miles (110 kilometers) on the Allegheny. Oceangoing ships can travel up the Delaware River as far as Philadelphia, and beyond to Morrisville. Philadelphia ranks as one of the leading port cities in the United States. Pittsburgh and Erie are also important port cities.

Communication. Pennsylvania's first newspaper, the *American Weekly Mercury,* was established in Philadelphia in 1719. It was the fourth newspaper published in the American Colonies, and the first published outside of Boston. Benjamin Franklin of Philadelphia published the *Pennsylvania Gazette* from 1729 until 1766, and *Poor Richard's Almanac* for the years from 1733 through 1758. In 1741, Andrew Bradford established America's first magazine, in Philadelphia. Bradford called his publication *The American Magazine, or A Monthly View of the Political State of the British Colonies.*

In 1919, Frank Conrad, an engineer of the Westinghouse Electric Corporation, set up a broadcasting station, 8XK, in his Wilkinsburg home. The following year, Conrad and some of the other Westinghouse engineers established radio station KDKA in Pittsburgh. It began broadcasting on Nov. 2, 1920. KDKA and Detroit's WWJ were the first regular commercial radio stations in the United States. Pennsylvania's first television station began broadcasting in Philadelphia in 1941. The station broadcasts as KYW-TV.

Pennsylvania has about 380 newspapers, of which about 85 are dailies. Leading newspapers include the *Philadelphia Inquirer,* the *Philadelphia Daily News,* the *Pittsburgh Post-Gazette,* and *The Morning Call* of Allentown. The *Philadelphia Tribune* is one of the nation's most widely circulated African American newspapers. More than 750 periodicals are published in Pennsylvania. The state has about 370 radio stations and 45 television stations. Cable television systems and Internet providers serve many communities.

Government

Constitution. Pennsylvania's Constitution was adopted in 1968. The state had adopted earlier constitutions in 1776, 1790, 1838, and 1874.

Constitutional *amendments* (changes) may be proposed by the state legislature. An amendment must be approved by a majority of both houses. It must then be approved in a similar manner by the next legislature. Finally, it must be approved by a majority of the people voting on the amendment in the next election.

Amendments also can be proposed by a constitutional convention. Before a constitutional convention can meet, it must be approved by a majority of both legislative houses and by the voters in a regular election.

Executive. Pennsylvania's governor is elected by the people to a four-year term. The governor may not serve more than two terms in a row.

The governor appoints the secretary of the commonwealth (secretary of state), adjutant general, and several other administrative officials. The people of Pennsylvania elect the lieutenant governor, the attorney general, the state treasurer, and the auditor general. Like the governor, these elected officials serve four-year terms. They may serve an unlimited number of terms, but not more than two terms in a row.

Legislature, called the General Assembly, consists of a 50-member Senate and a 203-member House of Representatives. Voters in each of the state's 50 senatorial districts elect one senator. Voters in each of the 203 representative districts elect one representative. Senators serve four-year terms, and representatives serve two-year terms. Regular sessions begin on the first Tuesday in January and last until all business is completed or until November 30 of an even-numbered year, whichever occurs first. The governor may call special sessions of the General Assembly. By law, the General Assembly must be *reapportioned* (redivided) after each United States census to provide equal representation based on population.

Courts. Pennsylvania's highest court is the state Supreme Court. It has seven justices, who are elected to 10-year terms. The justices may be *retained* (approved for an additional 10-year term in a noncontested election). The justice with the longest continuous time in office serves as the chief justice.

Pennsylvania's Superior Court and the Commonwealth Court are intermediate appellate courts. The Supreme Court, Superior Court, and Commonwealth Court meet at fixed times each year in Harrisburg, Pittsburgh, and Philadelphia. The Superior Court has 15 active judges, and the Commonwealth Court has nine. These judges are elected to 10-year terms and may be retained.

The trial courts of Pennsylvania are divided into 60 judicial districts, each with a Court of Common Pleas. Other courts include the Minor Judiciary, the Philadelphia Municipal Court, the Philadelphia Traffic Court, and the Pittsburgh Magistrates Court.

Local government. Pennsylvania has four kinds of local government units: (1) counties, (2) townships, (3) cities, and (4) boroughs. Sixty-two of the state's 67 counties are governed by a board of three commissioners, elected to four-year terms. Philadelphia is a consolidated city and county. It has a mayor and a 17-member council, who govern both the city and the county. Delaware County is governed by five council members, who serve four-year terms. Erie, Lehigh, and Northampton counties elect executives, who serve four-year terms.

Most rural and suburban communities operate as townships. Most of the larger townships are called first-class townships. They are governed by boards made up of at least five commissioners who are elected to four-year terms. Other townships, especially the smaller ones, are called second-class townships. These townships are governed by boards made up of three supervisors elected to six-year terms.

Pennsylvania has 56 cities. Many of these cities, including Philadelphia and Pittsburgh, use the mayor-council form of government. A few cities use the council-manager form. Many of Pennsylvania's smaller cities use the commission form of government.



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The Pennsylvania legislature consists of a Senate of 50 members and a House of Representatives of 203 members. The Senate meets in chambers, *above,* in the State Capitol in Harrisburg.

The state governors of Pennsylvania

	Party	Term
Thomas Wharton, Jr.*	None	1777-1778
George Bryan*	None	1778
Joseph Reed*	None	1778-1781
William Moore*	None	1781-1782
John Dickinson*	None	1782-1785
Benjamin Franklin*	None	1785-1788
Thomas Mifflin*	None	1788-1799
Thomas McKean	†Dem.-Rep.	1799-1808
Simon Snyder	Dem.-Rep.	1808-1817
William Findlay	Dem.-Rep.	1817-1820
Joseph Hiester	Dem.-Rep.	1820-1823
J. Andrew Schulze	Dem.-Rep.	1823-1829
George Wolf	Democratic	1829-1835
Joseph Ritner	Anti-Masonic	1835-1839
David R. Porter	Democratic	1839-1845
Francis R. Shunk	Democratic	1845-1848
William F. Johnston	Whig	1848-1852
William Bigler	Democratic	1852-1855
James Pollock	Whig	1855-1858
William F. Packer	Democratic	1858-1861
A. G. Curtin	Republican	1861-1867
John W. Geary	Republican	1867-1873
John F. Hartranft	Republican	1873-1879
Henry M. Hoyt	Republican	1879-1883
Robert E. Pattison	Democratic	1883-1887
James A. Beaver	Republican	1887-1891
Robert E. Pattison	Democratic	1891-1895
Daniel H. Hastings	Republican	1895-1899
William A. Stone	Republican	1899-1903
Samuel W. Pennypacker	Republican	1903-1907
Edwin S. Stuart	Republican	1907-1911
John K. Tener	Republican	1911-1915
Martin G. Brumbaugh	Republican	1915-1919
William C. Sproul	Republican	1919-1923
Gifford Pinchot	Republican	1923-1927
John S. Fisher	Republican	1927-1931
Gifford Pinchot	Republican	1931-1935
George H. Earle	Democratic	1935-1939
Arthur H. James	Republican	1939-1943
Edward Martin	Republican	1943-1947
John C. Bell, Jr.	Republican	1947
James H. Duff	Republican	1947-1951
John S. Fine	Republican	1951-1955
George M. Leader	Democratic	1955-1959
David L. Lawrence	Democratic	1959-1963
William W. Scranton	Republican	1963-1967
Raymond P. Shafer	Republican	1967-1971
Milton J. Shapp	Democratic	1971-1979
Richard L. Thornburgh	Republican	1979-1987
Robert P. Casey	Democratic	1987-1995
Tom J. Ridge	Republican	1995-2001
Mark S. Schweiker	Republican	2001-

*The office of governor was created by the Pennsylvania Constitution of 1790. That year, Thomas Mifflin became the first governor. Before 1790, Mifflin and those who served ahead of him held office as president of the state Supreme Executive Council.
†Democratic-Republican

Pennsylvania is one of the few states that has *boroughs*. These are incorporated units of municipal government that generally are smaller than cities. Most of Pennsylvania's boroughs are governed by a mayor and by councils elected to four-year terms.

Units of local government can adopt *home rule* (self-government) to the extent of selecting or changing their form of government. They can also merge with other units.

Revenue. Taxes account for more than half of the state government's *general revenue* (income). Most of the rest comes from federal grants and other U.S. government programs. A personal income tax and a general sales tax are the major sources of tax revenue. Other important sources of tax revenue include taxes on corporate income, corporation licenses, motor fuels, public utilities, and motor vehicle licenses.

Politics. Pennsylvania favored Republican candidates in most state and national elections between the American Civil War and the 1930's. Democrats have gained strength since the early 1930's, especially in the larger cities. Since 1932, Democratic and Republican presidential candidates have won the state's electoral votes about the same number of times. For Pennsylvania's electoral votes and voting record in presidential elections, see **Electoral College** (table).

History

Indian days. Indians probably lived in the Pennsylvania region thousands of years before Europeans came. Early European explorers found Algonquian and Iroquoian Indians there. The Algonquian tribes included the Conoy, Delaware, Nanticoke, and Shawnee. The Iroquoian tribe, the Susquehannock, lived along the Susquehanna River.

Exploration and settlement. In 1609, the English explorer Henry Hudson sailed into Delaware Bay. He was trying to find a trade route to the Far East for the Dutch East India Company. Hudson soon left the Pennsylvania region, but his reports led the Dutch to send other explorers. In 1615, a Dutch explorer, Cornelius Hendricksen, sailed up the Delaware River to what is now Philadelphia.

The Swedes made the first permanent settlements in the Pennsylvania region. In 1643, they made Tinicum Island, near what is now Philadelphia, the capital of their colony of New Sweden. In 1655, Dutch troops led by Peter Stuyvesant came from New Netherland and captured New Sweden (see **Stuyvesant, Peter**). The Dutch held the Pennsylvania region until 1664, when the English captured it.

The English Duke of York controlled the Pennsylvania region until 1681. That year, King Charles II of England granted the region to William Penn in payment of a debt to Penn's father. Penn wanted to name the region New Wales. But a Welsh member of England's Privy Council objected to the name. So Penn decided to call the region *Sylvania,* which means *woods*. King Charles added *Penn* to the name in honor of Penn's father, an English admiral.

Colonial days. William Penn, a Quaker, wanted his fellow Quakers to have freedom of worship in Pennsylvania. He also desired religious freedom for people of other faiths. Penn wanted Pennsylvanians to enjoy personal and property rights, and to have self-government. Penn came to Pennsylvania in 1682. As governor, he wrote and brought with him the colony's first constitution, called the Frame of Government. It provided for a deputy governor and an elected legislature. The legislature consisted of a provincial council (upper house) and a general assembly (lower house).

Penn made a treaty of friendship with the Indians shortly after he arrived in the Pennsylvania region. He paid the Indians for most of the land King Charles had given him, although he did not have to do so. According to legend, Penn and Tamenend, the chief of the Delaware Indians, exchanged wampum belts under the now famous Shackamaxon elm near Philadelphia.

The general assembly did not fully approve of the Frame of Government. In 1683, the legislature drafted and adopted a second Frame of Government. This constitution gave the people more voice in the government by reducing the powers of rich landowners.

Penn went to England in 1684, leaving control of the government in the hands of a deputy governor. Troubles developed during Penn's absence. Members of the general assembly resented the provincial council's power to originate laws. The assembly rejected or delayed action on much legislation that had originated in the council. When Penn learned about the trouble, he placed most of the powers of government in the hands of the provincial council. But the council failed to restore order. In 1688, Penn appointed another deputy governor.

In 1688, King James II, a close friend of Penn's, was overthrown. King James's daughter Mary and her husband, Prince William of Orange, became joint rulers of England in 1689. William and Mary did not trust Penn because of his friendship with King James. In 1692, they deprived Penn of his right to govern Pennsylvania. The royal governor of New York was made governor of Pennsylvania as well. In 1693, Penn convinced William and Mary of his loyalty. They restored him as governor of Pennsylvania in 1694.

Troubles still existed in the Pennsylvania legislature. In 1696, Penn's deputy governor, William Markham, suggested some constitutional changes. He wanted both legislative houses to have the power to originate laws. But this change still did not satisfy many members of the legislature.

Penn returned to Pennsylvania in 1699. In 1701, he granted a new constitution, called the Charter of Privileges. This constitution made the general assembly the only lawmaking body in the colony. It gave the provincial council an advisory role. It also gave greater control of the government to the people.

Penn returned to England again in 1701 and died there in 1718. Penn's family governed Pennsylvania until the Revolutionary War began in 1775.

Colonial wars. From the late 1600's to the middle 1700's, the English colonists fought several wars against the French colonists and France's Indian allies. In the



Engraving (1799) by William Russell Birch; American Philosophical Society Library, Philadelphia

The State House in Philadelphia (now called Independence Hall) is one of the most historic buildings in the United States. The Declaration of Independence and the U.S. Constitution were both signed there.

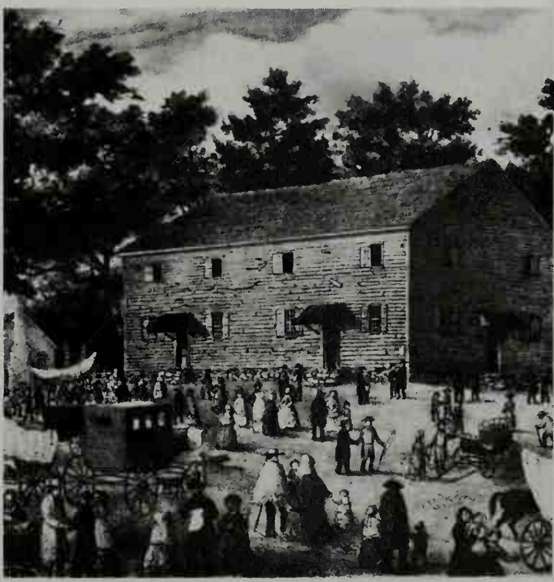
rench and Indian War, which began in western Penn-
ylvania in 1754, they fought for control of the Ohio
:iver region and interior of the continent. One of the
nost brutal battles of the war took place in 1755. The
rench and Indians ambushed General Edward Brad-
lock's troops on the banks of the Monongahela River
ear present-day Pittsburgh. Most of Braddock's sol-
liers were killed or wounded. Fighting continued in
'ennsylvania until 1758, when the French withdrew from
ne colony as British General John Forbes led a large
rmy through the region. The war ended in 1763, with a
ritish victory.

Pontiac, an Ottawa chief, led an uprising against the
ritish later in 1763. He lost the Battle of Bushy Run, near
resent-day Greensburg. Pennsylvania bought land from
ne Indians in the Fort Stanwix Treaty of 1768. This treaty
ettled most of the colony's Indian troubles.

The Revolutionary War. In the mid-1700's, Britain
ound itself in debt. To raise money, Britain imposed
ew taxes and trade restrictions on its colonies in Amer-
:a. The colonies united to oppose these measures. Co-
onial leaders met to discuss how to resist the British re-
trictions. The First Continental Congress met in Phila-
elphia on Sept. 5, 1774. The Congress voted to stop all
ade with Britain.

The Revolutionary War began in April 1775. That May,
ne Second Continental Congress met in Philadelphia.
he delegates voted for independence from Britain. On
ily 4, 1776, Congress adopted the final draft of the Dec-
ration of Independence in the Pennsylvania State
ouse (now Independence Hall) in Philadelphia. Penn-
lvania's first state convention was held in the State
ouse at the same time.

British troops in New York and New Jersey threatened
hiladelphia in December 1776. Congress moved to Bal-
more for safety. But the British were turned away, and
ongress returned to Philadelphia in March 1777. British
oops marched into Pennsylvania in September 1777.
They defeated General George Washington's forces in the Battle of Brandywine on September 11. The British then marched toward Philadelphia. Congress moved first to Lancaster, and then to York. On September 20 and 21, the British killed many American soldiers in the *Paoli Massacre,* outside Philadelphia. On September 26, the British marched across the Schuylkill River and captured Philadelphia. Washington led a sudden attack against the British on October 4, hoping to force them out of the city. But the attack failed. Washington led his



Bettmann Archive

A Quaker meeting house of the early 1800's served as a religious and social center. Many Quakers, seeking religious freedom, moved to Pennsylvania from Europe in the late 1600's.

Historic Pennsylvania



William Penn came to Pennsylvania in 1682. He made a treaty of friendship with the Indians and paid them for most of the land he got from King Charles.

The Constitution of the United States was signed in Philadelphia on Sept. 17, 1787.



The Declaration of Independence was adopted by Congress at the Pennsylvania State House (now Independence Hall) in 1776.

Edwin Drake drilled the nation's first commercially successful oil well, near Titusville, in 1859.

The Battle of Gettysburg in 1863 was a turning point in the Civil War. After three days of fighting, Confederate forces led by General Robert E. Lee retreated to Virginia.

Important dates in Pennsylvania



WORLD BOOK illustrations by Kevin Chadwick

1643 Swedish settlers established a capital on Tinicum Island, near present-day Philadelphia.

1655 Dutch troops from New Netherland captured New Sweden from the Swedes.

1664 The English took control of the Pennsylvania region from the Dutch.

1681 King Charles II of England granted the Pennsylvania region to William Penn.

1701 Penn granted the Charter of Privileges.

1754 The French and Indian War began in western Pennsylvania. The British won the war in 1763.

1763 Pontiac, an Ottawa chief, led a war against the British. The uprising ended with the Indians' defeat in the Battle of Bushy Run.

1774 The First Continental Congress met in Philadelphia.

1775 The Second Continental Congress met in Philadelphia.

1776 Congress adopted the Declaration of Independence in the Pennsylvania State House (now Independence Hall) in Philadelphia.

1787 The Constitutional Convention met at Philadelphia. Pennsylvania became the second state of the Union on December 12.

1859 Edwin Drake drilled the nation's first commercially successful oil well, near Titusville.

1863 Union forces defeated the Confederate Army of General Robert E. Lee in the Battle of Gettysburg.

1889 The Johnstown Flood killed more than 2,000 people.

1940 The first section of the Pennsylvania Turnpike opened. By 1956, the highway was completed across the state.

1967 Pennsylvania called its first constitutional convention in 94 years. The state adopted a new constitution in 1968.

1971 Pennsylvania adopted an individual income tax.

1979 An accident at the Three Mile Island nuclear power plant near Harrisburg threatened the release of deadly levels of radiation into the area. However, scientists and technicians prevented a major disaster.

1987 Pennsylvania marked the *bicentennial* (200th anniversary) of its statehood.

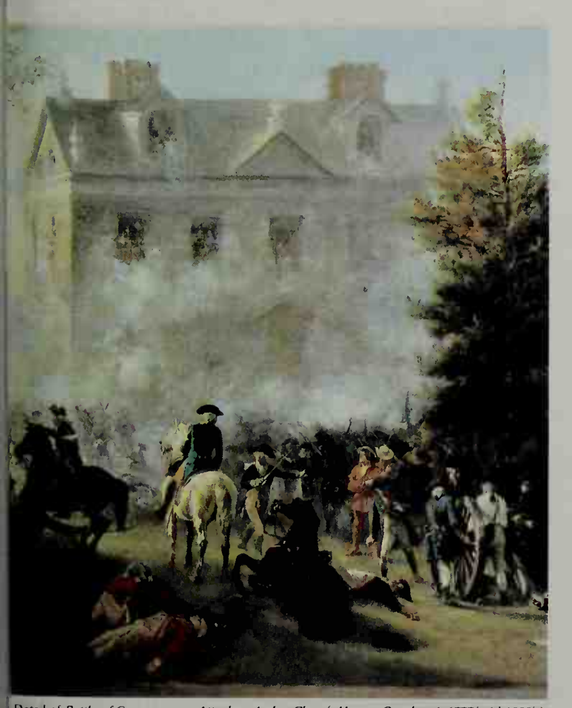
troops to Whitemarsh, and then to Valley Forge where they spent a difficult winter and spring.

In spite of their victories in Pennsylvania, the war was beginning to go badly for the British. In June 1778, they withdrew from Philadelphia. The Continental Congress returned to the city. While in York, the Congress had adopted the Articles of Confederation. Pennsylvania approved the Articles on July 9, 1778.

Meanwhile, settlers in the Wyoming Valley, in present-day Luzerne County, were in danger of attack by British and Indians. In the summer of 1778, the settlers fled to a fort near what is now Wilkes-Barre. That July, an army of about 800 British soldiers and Indians attacked the fort, killing about two-thirds of the settlers. The incident became known as the *Wyoming Valley Massacre.*

The Constitutional Convention met in Philadelphia from May to September 1787. Pennsylvania became the second state to *ratify* (approve) the United States Constitution, on Dec. 12, 1787. Philadelphia served as the nation's capital from 1790 until 1800, when the government was moved to Washington, D.C.

Industrial growth. As early as 1750, Pennsylvania had become a leader in the colonial iron and grain milling industries. After the Revolutionary War, Pennsylvania became a center of the nation's industrial growth. In 1787, John Fitch demonstrated the first workable steamboat in the United States. It sailed on the Delaware River, near Philadelphia. In 1811, a steamboat built by Robert Fulton was launched at Pittsburgh. It became the first to travel on the Ohio and Mississippi rivers. The Schuylkill Canal connected Philadelphia and Reading in 1825. In 1826, the state began building the Pennsylvania Canal System. The main line of the system, a series of connecting canals and railroads, linked Philadelphia with Pittsburgh by 1834.



Detail of *Battle of Germantown, Attack on Judge Chew's House, October 4, 1777* (mid-1800's), an oil painting on canvas by Alonzo Chappel; Chicago Historical Society

The Battle of Germantown took place north of Philadelphia after General George Washington led his troops in a surprise attack on the British army on Oct. 4, 1777.

By 1840, the use of anthracite as a fuel led to improvements in Pennsylvania's iron industry. By the 1850's, many railroads carried coal from northeast Pennsylvania to Philadelphia. In 1859, Edwin Drake drilled the nation's first commercially successful oil well, near Titusville. By 1860, Philadelphia was a leading producer of textile, leather, and iron goods. Pittsburgh, a center of iron and glass production, was known as the *Gateway to the West.*

The Civil War. Many Pennsylvanians were among the leaders of the *abolitionist* (antislavery) movement in the United States. Some Pennsylvanians helped slaves escape to freedom through a system called the underground railroad (see **Underground railroad**). During the Civil War (1861-1865), Pennsylvania gave strong support to the Union. The state sent 340,000 troops to the Union Army. Only New York sent more troops.

Several raids and one major Civil War battle took place in Pennsylvania. The Confederate cavalry generals Jeb Stuart and Wade Hampton led raids through the Cumberland Valley in October 1862. In June 1863, General Robert E. Lee led his powerful Confederate Army of about 75,000 men into Pennsylvania. On July 1, Union forces under General George G. Meade met the Confederates at Gettysburg, in southern Pennsylvania. The three-day battle that followed was one of the bloodiest in history. It broke the strength of the Confederacy, and Lee retreated to Virginia. On Nov. 19, 1863, President Abraham Lincoln dedicated part of the Gettysburg battlefield as a cemetery for those who had died there. He delivered his famous Gettysburg Address at the ceremonies.

Confederate General John McCausland invaded Pennsylvania in July 1864. His forces attacked and burned Chambersburg, and then they quickly left the state.

Progress as a state. Pennsylvania prospered after the Civil War. Existing agricultural, lumber, and mining industries expanded, and many new industries developed. Pennsylvania became a leading producer of oil, cement, electrical equipment, and aluminum. Pittsburgh became the largest steel producer in the United States. Thousands of immigrants came to the state, and cities and towns grew.

But industrial growth brought labor problems. Workers in many industries formed unions and demanded higher wages. Railroad workers went on strike in 1877. Riots broke out, and strikers destroyed valuable railroad property. In Pittsburgh, a violent clash between strikers and soldiers of the state militia left several people dead.

In 1892, the Carnegie Steel Company reduced wages at its plant in Homestead, and the workers went on strike. In a fight between strikers and guards hired by the steel company, several people were killed.

In 1889, Johnstown, in southern Pennsylvania, suffered one of the state's worst disasters—a flood that killed more than 2,000 people (see **Johnstown**).

Continued industrial growth. In the early 1900's, for the first time, more than half the people of Pennsylvania lived in cities and towns. Pennsylvania mined a large share of the coal in the United States. The state also produced most of the nation's coke and about 60 percent of

its steel. Many large industrial companies made their headquarters in Pennsylvania.

Manufacturing and mining in Pennsylvania achieved even greater growth after the United States entered World War I in 1917. In addition to production of military goods, the state contributed about 8 percent of the personnel of the U.S. armed forces.

The Great Depression. During the Great Depression of the 1930's, hundreds of thousands of Pennsylvanians lost their jobs. The state passed welfare laws in cooperation with the federal government to help ease the hardship. In addition, Pennsylvania set up programs of highway building, reforestation, and conservation, and passed laws that included a minimum wage for women and children, and a 44-hour workweek.

In 1936, floodwaters swept across many parts of the state. Pittsburgh and Johnstown were particularly hard hit. The floods killed more than 100 people and caused over $40 million in damage.

Urban renewal. Pennsylvania's economy recovered during World War II (1939-1945). The industries of the state produced huge quantities of cement, clothing, coal, petroleum, ships, steel, and weapons for the armed services.

Pennsylvania began to modernize in many fields during the mid-1900's. The first section of the Pennsylvania Turnpike opened in 1940. By 1956, the highway was completed across the state. During the 1940's, Pennsylvania cities began urban redevelopment programs. Pittsburgh rebuilt nearly all its downtown area, and Philadelphia modernized portions of its central city. In the 1950's, the state built hundreds of new schools and reorganized its welfare programs.

Economic decline. During the 1950's, serious economic problems developed. Pennsylvania's giant steel industry was hurt by competition from other products, and by a 116-day strike in 1959. The state's coal production fell sharply as the demand for anthracite and bituminous coal declined in the United States. Many mines closed, putting miners out of work. Thousands of Pennsylvanians also lost their jobs because of a decline in railroading. Thousands of other Pennsylvanians became jobless as textile mills were automated or moved to the South, where costs were lower.

In 1967, Pennsylvania called its first constitutional convention in 94 years. In 1968, voters approved a new constitution to replace the one that had been adopted in 1874.

In the 1970's and 1980's, Pennsylvania, especially its older cities, faced several difficulties. Many traditional manufacturing industries shut down or reduced the number of employees. The steel industry continued to decline because of foreign competition and other problems. Many more coal mines closed. Thousands of workers, especially steelworkers, lost their jobs, and many small industrial towns faced hard times.

The state's population growth leveled off. The average age of the population increased because many young adults left the state. The central cities of metropolitan areas faced such issues as high unemployment and loss of people to growing suburbs. Revenues of local governments declined.

These problems challenged Pennsylvanians to attract new industries, stabilize the older cities, and work to maintain such public structures as roads and bridges. In 1971, the state legislature approved an individual income tax to help pay state operating expenses. It also established a state-operated lottery which supported social programs for the elderly.



© Dirck Halstead, Gamma/Liaison

The Three Mile Island nuclear power plant near Harrisburg was the site of a nuclear accident in 1979. President Jimmy Carter, *center,* inspected the plant shortly after the accident.

In 1972, Tropical Storm Agnes swept across the Eastern United States. The storm and floods that it caused resulted in 55 deaths and about $3 billion in damage in Pennsylvania. Wilkes-Barre and Harrisburg suffered the most damage among Pennsylvania cities.

In 1979, an accident at the Three Mile Island nuclear power plant located near Harrisburg threatened the release of deadly levels of radiation into the area. Scientists and technicians prevented a major disaster from occurring. The accident raised concerns about the safety of nuclear power production.

Recovery. In the 1990's, Pennsylvania was able to achieve a balanced and healthy economy. With the support of the state government, the state's strong educational, financial, medical, and cultural institutions led the shift from older manufacturing activities to an economy based on service industries.

Although Pennsylvania remained a leading steelmaking state, service industries transformed the metropolitan areas of Philadelphia, Pittsburgh, Allentown, and other Pennsylvania cities. Workers found employment in such areas as medical research, health care, and interstate banking and in industries using new technology.

Pennsylvania worked to preserve and restore many historic sites and buildings, especially in Philadelphia and Pittsburgh. The state also established several *heritage parks.* These areas highlight the history of various regions and the role each played in the state's industrial development. These activities created thousands of jobs and attracted millions of dollars in new investment. They also contributed to the growth of the state's tourism industry. Edward K. Muller and William C. Rense

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Questions

Why was William Penn deprived of his right to govern Pennsylvania in 1692?
What rivers link Pittsburgh with the Gulf of Mexico?
When was Philadelphia the capital of the United States?
Where was the country's first commercially successful oil well drilled?
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Who founded America's first subscription library? What was it called? Where was it established?
Why did the Continental Congress have to leave Philadelphia in 1777?
From what region in Pennsylvania does all the hard coal in the United States come?
What major Civil War battle was fought in Pennsylvania? What important effect did this battle have on the outcome of the Civil War?
What Pennsylvania city is the home of the world's largest chocolate factory?
What were two of the reasons why many workers in Pennsylvania lost their jobs during the 1950's?

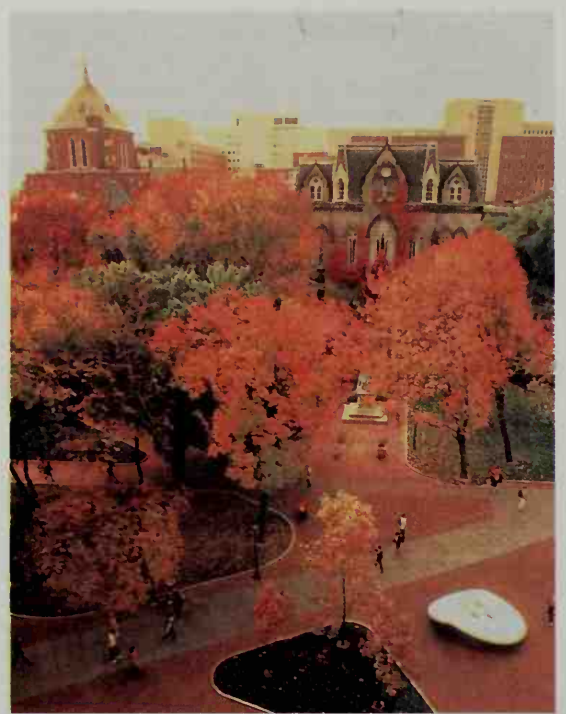
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University of Pennsylvania

The University of Pennsylvania is one of the oldest U.S. universities. Its campus has buildings that date from the 1700's.

Pennsylvania, University of, in Philadelphia, is one of the oldest institutions of higher learning in the United States. It is a privately controlled, coeducational school, but it receives a small portion of its operating budget from the state. Benjamin Franklin was one of the school's founders. It started in 1740 as a Charity School, became an Academy in 1749, and was named the College and Academy of Philadelphia in 1756. In 1791, it adopted its present name and became the first school in the United States to be called a university.

The university offers undergraduate courses in engineering; finance and commerce; liberal arts and sciences; and nursing. The Wharton School was the first collegiate business school in the United States. The graduate and professional schools offer courses in architecture and fine arts; arts and sciences; communications; dental medicine; education; law; medicine; social work; and veterinary medicine. The Wharton School and the nursing and engineering schools also have graduate divisions. Other academic divisions are the College of General Studies and the Wharton Evening School. The University of Pennsylvania also has several noted research institutes.

The university library includes special collections on medieval history, Shakespeare, Sanskrit manuscripts, Italian Renaissance, and Walt Whitman. The Union Library Catalogue lists 6 million volumes owned by libraries in the Philadelphia area.

The university museum has noted collections of Babylonian material, Chinese sculpture, and Middle American, Pacific, and African art. It conducts archaeological expeditions each year.

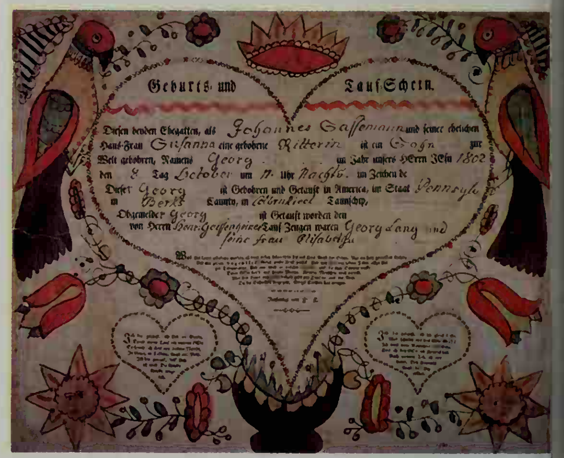
Critically reviewed by the University of Pennsylvania

Pennsylvania Dutch refers to the people who came to Pennsylvania in the late 1600's and the 1700's from the German Rhineland, and their descendants. Some of these immigrants came from the German part of Switzerland, and others were French Huguenots. Only a few of them came from the Netherlands. The Pennsylvania Dutch were called *Dutch* because the word *Deutsch,* which means *German,* was misinterpreted.

These settlers came to Pennsylvania to escape war and religious persecution in the Rhineland. They settled mainly in southeastern Pennsylvania. By 1790, the Pennsylvania Dutch made up one-third of Pennsylvania's population.

The Pennsylvania Dutch valued their agricultural life and worked their fields industriously. The community often worked together to provide assistance to individuals in farm and social matters. These qualities helped the Pennsylvania Dutch prosper as farmers.

Most of the original Pennsylvania Dutch belonged to the Lutheran or German Reformed churches. They were called "the church people." Others belonged to various *sects* (religious groups) that grew out of *pietism,* a religious movement that opposed formal religious practices. These sects included the Amish and Mennonites. These two groups were noted for their plain dress and distrust of formal church practices. Today the Amish and Mennonites are called "the plain people," and live mainly in Lancaster County. Another early group, the Moravians, founded Bethlehem, Pennsylvania, and worked to convert American Indians to Christianity. See **Amish; Mennonites; Moravian Church.**



The State Museum of Pennsylvania Pennsylvania Historical and Museum Commission

Pennsylvania Dutch folk art includes this colorful hand-drawn birth and baptismal certificate from the early 1800's.

Pennsylvania Dutch artisans became well known for their clocks, glassware, pewterware, and pottery. They also invented the Conestoga wagon and the Pennsylvania rifle. Many Pennsylvania Dutch still maintain their dialect and unique customs. Their distinctive art style is known for its colorful decorative motifs. Many Pennsylvania Dutch buildings are decorated with colorful designs called *hex signs.* Such hex signs as a star within a circle were once intended to protect against evil spirits, but they now serve mainly as decoration.

The people's love of music has resulted in beautiful church music, especially choirs such as the famed Bach choir. Characteristic dishes include *sauerkraut un schpeck* (sauerkraut and pork), *smearcase* (cottage cheese), and *schnitz un knepp* (dried apples and dumplings).

Edward K. Muller

See also Folk art (Folk art collections).

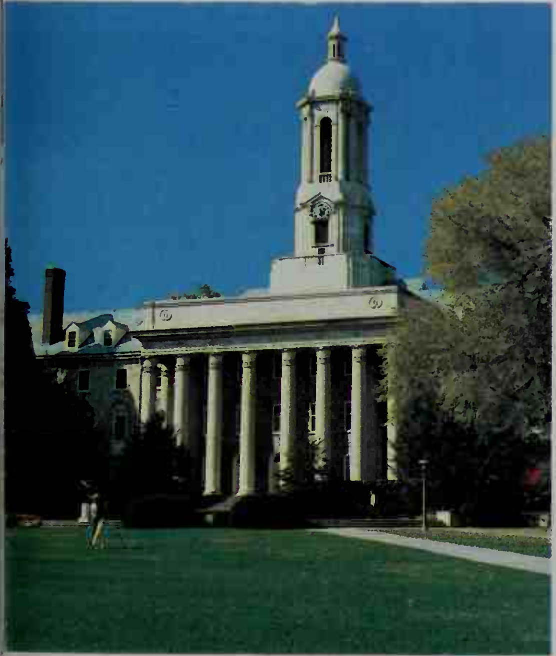
Pennsylvania State University is a coeducational land-grant institution that offers advanced education at more than 20 locations in Pennsylvania. The university, popularly known as Penn State, grants associate's, bachelor's, master's, and doctor's degrees.

Penn State is a major research university with programs in agricultural science, architecture, business, communications, earth and mineral sciences, and education. Additional programs include engineering, food science, health and human development, law, liberal arts, medicine, and physical and life sciences.

Penn State's main campus is University Park, in University Park, Pennsylvania. Many courses of study are available at University Park, including business, engineering, food science, liberal arts, and physical and life sciences. Penn State also has a network of colleges that grant associate's degrees. Most of these colleges also offer bachelor's degrees in a few specialized areas. The Pennsylvania College of Technology, in Williamsport, offers technical and vocational associate's degrees.

Penn State provides a wide variety of graduate programs at University Park and several other sites. The College of Medicine at the Milton S. Hershey Medical Center, in Hershey, offers degrees in medicine and other health sciences. Students can earn law degrees at Dickinson School of Law, in Carlisle.

Critically reviewed by Pennsylvania State University



James Collins, Penn State

Old Main, a Pennsylvania State University landmark, is the administration building on the University Park Campus.

Pennsylvania Turnpike is a 470-mile (755-kilometer) toll superhighway. It was the first successful American toll highway of any great length built for all types of motor vehicles. The turnpike's main line runs for 360 miles (580 kilometers) across Pennsylvania, from Ohio to New Jersey. The Northeastern Extension runs for 110 miles (180 kilometers) from a point near Norristown to an area north of Scranton. About 300,000 vehicles enter the turnpike system each day. The total mileage for all vehicles traveling on the turnpike in one year is about 4 $\frac{1}{4}$ billion miles (7 billion kilometers).

The turnpike opened in 1940. At that time, it spanned 160 miles (260 kilometers) from Irwin (near Pittsburgh) to Middlesex (near Carlisle).

Critically reviewed by the Pennsylvania Turnpike Commission

Penny is the name used to describe various coins that are used in the United Kingdom, the United States, and other countries. The U.S. penny is a cent (see Cent). For many years, there were 240 British *pence* (pennies) in a pound. But in 1971, the United Kingdom switched to a decimal money system. In this system, 100 *pence* are equal to a pound. The penny was stamped with the symbol of a cross until about 1500, during the reign of Henry VII. At that time, the coin was designed so that it could easily be broken into four equal parts. It was used in halves as a *halfpenny* (pronounced *HAY puh nee*) and in fourths as a *farthing*. The old penny was abbreviated *d*, but today's penny is abbreviated *p*. For the price of the pound in United States dollars, see Money (table).





WORLD BOOK photos

The British penny honors Queen Elizabeth II on its front and has a royal crown and an iron gate with chains on the back.

R. G. Doty

See also Denarius.

Penny dreadful. See Valentine's Day.

Pennyroyal, *PEHN ee ROY uhl,* is the name of several herbs of the mint family. Pennyroyal leaves have a strongly pungent odor. The oil from various kinds of pennyroyals is used in medicine, mosquito repellents, and perfumes. Lyle E. Craker

Scientific classification. Pennyroyals belong to the mint family, Lamiaceae or Labiatae.

Pennyweight is a unit of measure in the troy system of weights. It is used to weigh gold, silver, platinum, coins, and most jewels. The pennyweight was once the weight of a silver penny. Today it is standardized as one twentieth of a troy ounce, or 24 grains (1.6 grams).

Penobscot River, *puh NAHB skaht,* is the longest waterway in Maine. It rises near the Canadian border and flows eastward through forests (see Maine [physical map]). The river forms Chesuncook and Pemadumcook lakes. It then flows south for the rest of its 350 miles (563

kilometers) to empty into Penobscot Bay, on the Atlantic Ocean. Ocean vessels can sail up the river to Bangor, 60 miles (97 kilometers) from the sea. The name *Penobscot* comes from the Algonquian Indian words for *rocky river.*

Paul B. Frederic

Penology. See Criminology (What criminologists study).

Pensacola (pop. 56,255; met. area pop. 412,153) is Florida's largest deepwater seaport. It lies on Pensacola Bay in northwestern Florida. For the city's location, see **Florida** (political map). Its chief industries include chemical plants, fertilizer, fishing, furniture and boat making, and pulp and paper mills. The University of West Florida is in Pensacola. The area is the site of the Pensacola Naval Air Station (see **Pensacola Naval Air Station**).

Diego Maldonado, one of explorer Hernando de Soto's captains, reached Pensacola Bay, probably in 1540. In 1559, Spanish adventurer Tristan de Luna founded a settlement that lasted two years. Spain reoccupied Pensacola in 1698, when Spanish military leader Don Andres d'Arriola built a fort where the city now stands. Pensacola has a council-manager government. It is the seat of Escambia County. Peter O. Muller

Pensacola Dam is a federal flood-control and electric-power project on the Neosho River near Pensacola, Oklahoma. It is a multiple-arch, hollow-buttress dam with 51 arches and an 861-foot (262-meter) spillway. The dam is 145 feet (44 meters) high and 6,500 feet (1,980 meters) long at the top. It has a capacity of 2 million acre-feet (2.5 billion cubic meters) of water. The dam was completed in 1940. Larry W. Mays

Pensacola Naval Air Station, Florida, serves as the headquarters of the Chief of Naval Education and Training, a command that directs and controls all education and training for the United States Navy. Flight training for most Navy aviators begins at the station, which covers 11,386 acres (4,608 hectares) and lies 9 miles (14 kilometers) west of Pensacola. Major activities there include the Naval Air Technical Training Center and the Naval Operational Medicine Institute. The Naval Aviation Museum is also there. The Pensacola Naval Air Station was set up in 1914 on the site of an old naval shipyard. It reached a peak of activity in World War II (1939-1945), when 28,000 aviators trained there. W. W. Reid

Pension is a form of income that workers or their spouses receive after the workers retire, become disabled, or die. Pension plans benefit people who have had careers in private industry; in a nation's armed forces; or in national, state, and local governments. Many individuals who are self-employed or whose employers do not provide a pension establish their own pension plans.

About half the privately employed people in the United States, and nearly all United States government employees, are covered by some type of employer-sponsored pension plan. In addition, a government program commonly known as *social security* provides pension benefits to most United States workers after they retire. Workers in other countries also are covered by pension systems. This article discusses pension plans in the United States.

Most federal pensions are financed by contributions made by both employees and the employer. Most private group pension plans are funded by the employer only. Many people collect benefits from more than one pension plan.

Federal pension plans

The U.S. government administers four major types of pension plans: (1) social security, (2) railroad pensions, (3) military pensions, and (4) federal civilian pensions.

Social security is the largest retirement income pro-



U.S. Navy

Pensacola Naval Air Station is on Pensacola Bay near the Gulf of Mexico. United States Navy pilots and other aviation personnel begin their training at the station.

gram in the country. The Social Security Administration, a government agency, runs the program. Employees pay part of their salaries to social security through the Federal Insurance Contributions Act (FICA) payroll tax. Employers contribute the same amounts paid by their employees. Most self-employed workers also pay part of their earnings to the program. Eligible people who retire at age 65 or older may get full social security benefits for the rest of their lives. Those retiring between 62 and 65 receive reduced benefits. For example, at age 62 people are eligible for 80 percent of their full benefits.

The social security program was established in 1935. Since then, the number of people receiving benefits has increased steadily. Benefits are raised each year to reflect increases in the cost of living. However, most people who receive social security must supplement it with income from other sources.

Railroad pensions provide retirement income for railroad workers. They are the only type of private industry pension managed by a government agency. The agency that manages them is the Railroad Retirement Board. Employee and worker contributions are supplemented by government revenues. Railroad workers qualify for a pension after 10 years of service. Retirees who are 65 or older, or are 62 or older and have worked at least 30 years, receive full benefits. The current railroad pension system was established in 1936.

Military pensions have provided retirement income for disabled veterans since the Revolutionary War (1775-1783) and for retired veterans since the early 1800's. The Uniformed Services Retirement System includes all military pension programs. It is funded by federal revenues.

Military personnel who have served a minimum of 20 years can retire at any age and receive benefits. Retirees receive pensions equal to 40 percent of their active-duty base pay if they retire after 20 years of service. Benefits reach a maximum of three-quarters of their active-duty base pay after 30 years of service.

Federal civilian pensions provide income for retired government employees other than military personnel. Many federal workers are covered by the Civil Service Retirement System (CSRS), which is funded by employees and the government. Workers receive full benefits if they retire at age 62 with at least 5 years of service; at age 60 with at least 20 years of service; or at age 55 with at least 30 years of service. In addition, many CSRS retirees qualify for social security benefits.

Federal employees hired during or after January 1987 are covered by the Federal Employees' Retirement System (FERS), which was established in 1986. The FERS also includes some employees formerly covered by the CSRS. The FERS provides benefits from social security, a federal retirement plan, and a thrift savings plan. The FERS retirement plan generally pays lower benefits than does the CSRS. The government contributes to the FERS thrift plan and matches a certain percentage of contributions made by employees to that plan.

Private pension plans

Many companies provide some type of pension program for their employees. In most programs, the benefits depend on an employee's age, years of service, and average salary. Federal law requires that all pension plans offer *vested pension rights* to workers who have completed a certain number of years of service. Most employees become fully vested after five years or less of service. Employees with vested rights are guaranteed pension benefits after retirement even if they leave the firm before they retire. However, almost no pension plans provide cost-of-living increases.

There are four main kinds of private pension programs. These programs include (1) trust-fund plans, (2) group annuity plans, (3) profit-sharing plans, and (4) thrift, or savings, plans.

Trust-fund plans pay benefits from a trust managed by a bank or other financial institution. Money paid to the pension funds is invested in stocks, bonds, and other sources of income. Most of the money is paid by the employer. Many employers who participate in trust-fund plans must pay premiums to a federal agency called the Pension Benefit Guaranty Corporation to insure worker benefits against inadequate funding.

Group annuity plans cover all participants with an insurance policy financed either by the employer alone or by both the employer and the employees. The policy guarantees that each worker will receive a monthly *annuity* (payment) after retiring. Life insurance firms manage most group annuity plans.

Profit-sharing plans are funded by employers, largely from a portion of their annual profits. People may be paid in monthly installments or with one lump sum.

Thrift, or savings, plans allow employees to make contributions for retirement. In most thrift plans, the employer matches a certain percentage of each employee's contributions. Companies typically match 50 percent of an employee's contributions up to a certain maximum amount. In most cases, an employee may contribute amounts above the maximum matched amount. One common type of company thrift plan is a *401 (k) plan.* Under this plan, all or part of the contributions come from pretax income, and taxes are deferred until money is withdrawn. Withdrawals or loans from such an account are permitted up to a set limit and only under certain conditions. If the employee exceeds the limit or does not meet the conditions, a federal penalty tax must be paid. Many employers provide a thrift plan in addition to another type of pension plan.

Individual pension plans

Many people put part of their income into an individual pension program. The two chief types of individual programs are *individual retirement accounts* and *Keogh plans.*

Individual retirement accounts are special savings accounts administered by such financial institutions as banks, savings and loan associations, and insurance companies. The money in an individual retirement account (IRA) earns interest that is automatically added to the account. In a traditional IRA, people who do not have private pension plans, or who earn less than a certain amount, may deposit a certain sum into the account each year without having to pay income tax on the deposited money until it is withdrawn. Others may make deposits but must pay tax on the money they deposit, at the time it is earned. The interest earned on any funds in a traditional IRA is not taxed until withdrawn.

In general, if an individual withdraws previously untaxed money from the account before reaching the age

of 59 $\frac{1}{2}$, a federal penalty tax must be paid. This rule does not apply when the money is withdrawn to pay for certain college expenses or to finance the purchase of a first home. At the age of 70 $\frac{1}{2}$, a person must withdraw all the funds from the account or start making periodic withdrawals.

In a type of IRA known as a Roth IRA, the money deposited in the account is subject to federal income tax at the time it is earned. But the government does not tax interest earned on the account.

Keogh plans may be set up only by people who are self-employed or who own all or part of an unincorporated business. Like IRA's, Keogh accounts are handled by banks and other financial institutions, and the money is not taxed until it is withdrawn.

History

In 1875, a transport firm called the American Express Company offered the first U.S. private pension plan. In 1880, railroads became the first major industry to provide a pension plan, and other industries soon established their own plans. Labor unions created pension funds for their members during the early 1900's. In 1935, Congress established the social security system.

In 1974, Congress passed the Employee Retirement Income Security Act (ERISA). This act set standards for private pension plans. Since the 1980's, the proportion of workers covered by private pensions has declined. Many companies have begun putting more emphasis on thrift plans instead. James H. Schulz

See also **Inflation** (Effects on income); **Profit sharing; Social security; Townsend Plan; Veterans Affairs, Department of; Workers' compensation.**

Additional resources

Gaudio, Peter E., and Nicols, V. S. *Your Retirement Benefits.* Wiley, 1992.
McGill, Dan M., and others. *Fundamentals of Private Pensions.* 7th ed. Univ. of Penn. Pr., 1996.

Pentagon is a polygon having five sides. It is called *equilateral* if all sides have the same length and *equiangular* if all its angles are equal. Like all polygons, except a triangle, a pentagon may be equilateral without being equiangular. Or it may be equiangular without being equilateral. A pentagon is *regular* if all the sides and interior angles are equal. Each angle equals 108° and may be inscribed in a circle. A pentagon may be circumscribed around a circle by drawing tangents to the circle at the vertices of a regular inscribed pentagon. See also **Polygon.**

Philip S. Marcus



WORLD BOOK illustration

An equilateral pentagon is a polygon that has five sides of the same length.

Pentagon Building is one of the world's largest office buildings. It is the headquarters of the Department of Defense of the United States government. The building lies on the west bank of the Potomac River in Arlington, Virginia, across from Washington, D.C.

Built in the form of a *pentagon,* or five-sided figure, the building has five concentric rings connected by 10 spokelike corridors. It has five floors, a mezzanine, and a basement. The building covers 29 acres (12 hectares) and has about 3,706,000 square feet (344,300 square meters) of office and other space. The outermost wall of the concrete structure is faced with Indiana limestone. The building is surrounded by 200 acres (81 hectares) of lawn and terraces. Adjacent parking areas cover 67 acres (27 hectares). The lagoon at the building's river entrance was formed by excavation and juncture with the river.



Department of Defense

The Pentagon Building is one of the largest office buildings in the world. The five-sided structure stands across the Potomac River from Washington, D.C.

About 24,000 people work in the building. Most of them work for the departments of the Army, Navy, or Air Force, or the Office of the Secretary of Defense. About half of them are civilians.

The Pentagon Building has one of the world's largest private telephone systems and the largest pneumatic tube system. Pneumatic tubes transport letters and other such materials by means of air pressure. The building also has many shops, several cafeterias and restaurants, a radio and television station, a bank, a medical dispensary, a post office, and a heliport.

Army engineers began building the Pentagon in September 1941 and completed it by January 1943. It was built to house the scattered offices of the War Department under one roof. The building cost $83 million.

On Sept. 11, 2001, the Pentagon Building was damaged in the worst terrorist attack in U.S. history. Terrorists in a hijacked commercial jetliner crashed the plane into the Pentagon, cutting a gash in one side of the building and setting it on fire. Two other hijacked planes crashed into the two towers of the World Trade Center in New York City. A fourth hijacked plane crashed in Pennsylvania. Thousands of people died as a result of the attacks. Critically reviewed by the Department of Defense

Pentameter. See **Meter** (poetry).

Pentateuch, *PEHN tuh took,* consists of the first five books of the Bible. They are, in order, the books of Genesis, Exodus, Leviticus, Numbers, and Deuteronomy. The term comes from two Greek words that mean *five books* or *five scrolls.* According to tradition, the books were written by the Israelite leader Moses based on revelations from God. The Pentateuch is often called the Five

Books of Moses or the Torah (Law) of Moses.

The Pentateuch presents a continuous story from the Creation to the death of Moses and the preparation of the Israelites to enter Canaan. The story is told in three sections, sometimes called the *prehistory* or *primeval history,* the *protohistory,* and the *history.* The prehistory (Genesis 1-11) deals with the universal themes of the Creation and the beginning of human existence on earth. The protohistory (Genesis 12-50) presents the stories of several ancestors of the Israelites, notably Abraham, Isaac, Jacob, and Joseph. The historical portion, beginning with Exodus, describes the early history of Israel as a nation. The conclusion in Deuteronomy is presented as Moses's final address to his people and a kind of historical summary of the Pentateuch.

The Pentateuch is the oldest part of the Bible, though scholars do not know the precise date of composition. The earliest materials may precede its final form by more than 1,000 years. Modern archaeological discoveries suggest that some of the oldest stories in Genesis may date back to the 2000's B.C. Carol L. Meyers

See also **Bible** (Books of the Hebrew Bible); **Moses;** and the separate articles on each book mentioned.

Pentathlon, Modern, *pehn TATH lahn,* is an athletic competition for men and women that tests skill in pistol shooting, fencing, swimming, horseback riding, and running. Competitors participate in all five events, receiving a point score for each performance. The athlete with the highest score wins. The modern pentathlon can be held in both individual and team categories. It differs from the pentathlon, which consists of five track and field events.

The modern pentathlon is held in one day in both the Summer Olympic Games and in world championships. The first event is shooting an air pistol. Next is fencing with an epee sword. The third event is freestyle swimming, in which the athletes swim a 200-meter race. The fourth event is horseback riding over a course 350 to 450 meters (1,150 to 1,475 feet) long with 12 obstacles. The final event is a 3,000-meter cross-country race. Michael Takaha

See also **Heptathlon; Olympic Games** (table: Modern pentathlon).

Pentecost, *PEHN tuh kawst,* is the feast that marks the end of the 50-day Christian observance of Easter. The term comes from the Greek word for *fiftieth.* Pentecost originally celebrated both the Ascension of Jesus Christ and the descent of the Holy Spirit. In the 300's, the Ascension of Jesus came to be a separate observance. However, Pentecost remained a celebration of the gift of the Holy Spirit to the church, in fulfillment of Jesus's promise "And I will pray the Father, and he shall give you another comforter, that he may abide with you for ever" (John 14:16). During early church history, the term *Pentecost* also referred to the period of 50 days following Easter. This period was the time of the celebration of the Resurrection of Jesus.

In the 1900's, this emphasis was recovered in a number of churches, including the Roman Catholic Church, the Eastern Orthodox Churches, most Lutheran churches, and the churches of the Anglican Communion. In these churches, the season of Easter is observed throughout the seven weeks until Pentecost.

In ancient Israel, Pentecost was the celebration of the wheat harvest held 50 days after the festival of Passover. Since Biblical times, the celebration also commemorates the day the Ten Commandments were revealed to Moses on Mount Sinai. In Judaism, this event is observed in the holiday of Shavuot, which falls in May or June. David G. Truemper

See also **Shavuot; Easter; Trinity; Christianity** (The origin of Christianity).

Pentecostal churches, *PEHN tuh KAWS tuhl,* are a group of Protestant churches that trace their origins to a religious revival that began in Topeka, Kansas, in 1901. The movement spread rapidly in the United States. Similar revivals took place in Europe, Asia, and Latin America. Today, some of the world's largest and fastest-growing Protestant denominations are Pentecostal.

Beliefs and practices. Pentecostals claim that all individual Christians should experience "baptism in the Holy Spirit." Proof of "Spirit baptism" generally comes when the person receives the gift of *speaking in tongues*—that is, speaking in an unknown language. Pentecostals take their name from the New Testament reference to the disciples speaking in tongues on the day of Pentecost (Acts 2). Pentecostals also believe that they can receive other gifts of the Holy Spirit. These gifts include the power of physical healing and the abilities to prophesy and to interpret what is said when someone speaks in an unknown tongue. Such gifts are described in I Corinthians 12 and 14.

Pentecostals believe that history will end with the Second Coming of Jesus Christ. They believe their movement fulfills Biblical prophecies of a religious revival before the end of the world. They view *evangelism* (the spreading of their religious message) as a solemn obligation to prepare the world for Jesus's return.

Pentecostal worship services tend to be highly emotional and filled with a sense of the wonder and miracle of the Holy Spirit's presence. The celebration and use of spiritual gifts, as well as prayers for the healing of the sick, are typical practices in many congregations.

Pentecostal churches differ from one another in size and in their interpretations of faith and practice. For example, some Pentecostal denominations are controlled by individual congregations. Other Pentecostal denominations are led by bishops.

Major Pentecostal churches. In the United States, there are about 30 sizable Pentecostal denominations. Many other small, regional churches identify with the Pentecostal movement but do not call themselves Pentecostal churches. In addition, a related movement of *charismatic renewal* began during the 1960's. It involved many Protestants and Roman Catholics who claimed to have experienced Spirit baptism.

The earliest Pentecostal churches grew out of the *Holiness movement* of the late 1800's. Members of Holiness churches acknowledged two acts of grace: (1) conversion, or being "born again"; and (2) sanctification or a "second blessing," meaning a cleansing from sin.

Charles Fox Parham, an independent Holiness preacher, is believed to have originated the Pentecostal revival. In 1901, people began speaking in tongues at his Bethel Bible College in Topeka. Parham claimed that such speech indicated "true baptism in the Spirit." Parham added Spirit baptism to the two acts of grace accepted by Holiness churches. William Joseph Seymour, a black

Holiness preacher, brought the movement to the Azusa Street Apostolic Faith Mission in Los Angeles in 1906.

The first Pentecostal church was the Church of God (Cleveland, Tenn.). This former Holiness church accepted Pentecostal teaching about Spirit baptism in 1907. Other Pentecostal churches with Holiness roots include the Church of God in Christ and the International Pentecostal Holiness Church. See **Church of God in Christ, The.**

Other Pentecostal churches reject the idea of a "second blessing." They teach only conversion and Spirit baptism. One such church, the Assemblies of God, is the largest Pentecostal church. See **Assemblies of God.**

A group of Pentecostal churches known as *Oneness churches* formed out of the Assemblies of God after 1916. These churches reject the traditional Trinity of the Father, the Son, and the Holy Spirit. Instead, they hold that the Bible calls for baptism only "in the name of Jesus." Such churches include the United Pentecostal Church International and the Pentecostal Assemblies of the World, Inc. Edith L. Blumhofer

Pentode. See Vacuum tube.

Pentothal. See Thiopental.

Penumbra, *pih NUHM bruh,* means *partial shadow.* Suppose an object such as the earth blocks the light given off by a larger source such as the sun. Behind the earth, there is a dark shadow where none of the sun's rays pass. Outside this dark region is another, less dark region, where some of the light passes. This partially dark region is called the *penumbra.* The inner dark region is called the *umbra.* The moon is almost totally dark when it passes through the umbra of the earth's shadow. This occurrence is called a *total eclipse* of the moon.

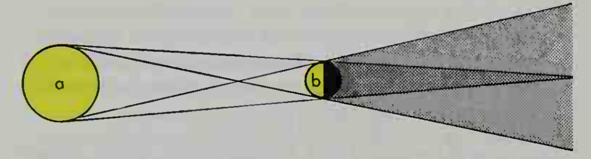


Diagram of the penumbra. The sun, the source of light, is labeled (a), while (b) is a sphere on which the light falls. The heavily shaded cone behind (b) shows the umbra, where there is almost total darkness. The lightly shaded area shows the penumbra, which is in partial shadow.

You can see an umbra and a penumbra in the shadow of your hand. Hold your hand a few feet from a lamp in a room with no other light. Place a piece of white paper on the other side of your hand. Your hand casts a shadow on the paper. In the center of the shadow of each finger is the dark umbra. Around each umbra is a brighter penumbra. Jearl Walker

See also **Shadow; Sunspot.**

Peonage, *PEE uh nihj,* is a system of forced labor in which the *peon* (laborer) is forced to work in payment of a debt. The word *peon* comes from the Spanish *peón,* meaning *day laborer.*

Peonage was common in most of the Spanish colonies of the Americas until the early 1900's, when nearly every civilized country of the world passed laws abolishing the practice. In Mexico, many Indians were forced to work out petty debts. The system was abolished in Mexico in 1917. But the term *peon* is still used to mean the impoverished Indian laborers of Latin America. These agricultural workers live on their employer's land and may receive a small payment for their work.

Peonage existed in the United States, particularly in the present states of New Mexico and Arizona, a short time after slavery was abolished. Blacks were arrested on false charges and fined. If they were not able to pay the fine, they were given to the highest bidder to work without wages for a period of time. At the end of this period, they could be arrested again and forced into service. In 1911, the Supreme Court declared all forms of peonage unconstitutional. Warren Van Tine

Peony, *PEE uh nee,* is the common name of a group of plants with large, handsome flowers. In early spring, peonies have shrubby or herblike stems. The clusters of leafy shoots, red and shiny green in appearance, make a striking effect a few weeks before the flowers appear in late spring or early summer.

Many of the cultivated varieties of peonies common in America are the offspring of two species of the Eastern Hemisphere, the *common peony* of southern Europe and the *Chinese peony.* The large flowers of the common peony are white, red, or crimson and are lovely to look at, although they do not have much fragrance. Many of the Chinese peonies, a large group of hybrids, bear double, sweet-scented blossoms. The peonies with woody stems are called *tree* or *moutan peonies.* This kind of peony is a native of western China. It has showy flowers that blossom in white and rose-colored hues and grow on a stalk from 3 to 4 feet (91 to 120 centimeters) high. Tree peonies grow slowly. In regions of late spring frosts, the buds are often injured. Once established, they bloom season after season. Bush peonies are planted by dividing the shoots.

Scientific classification. Peonies were long placed in the crowfoot family, Ranunculaceae. Today, botanists consider peonies to make up the peony family, Paeoniaceae. The common peony is *Paeonia officinalis;* the Chinese is *P. lactiflora.* Most tree peonies in America are *P. suffruticosa.* Roy E. Gereau

See also **Flower** (picture: Garden perennials).



WORLD BOOK illustration by Robert Hynes

The tree peony has large flowers that grow on tall stalks. This variety of the plant produces white and rose-colored blossoms.

People. See Human being.

People for the Ethical Treatment of Animals (PETA) is one of the largest animal rights organizations in the world. It promotes the belief that animals deserve moral consideration and should not have to suffer to fulfill human desires. PETA objects to all mistreatment of animals. However, the organization concentrates its efforts on ending the use of animals in research laboratories, in the fur industry, in sports and entertainment, and on *factory farms.* On factory farms, large numbers of food animals are usually raised indoors in pens.

PETA works to achieve its goals through consumer boycotts, educational efforts, lawsuits, protests, and undercover investigations. PETA is well known—and sometimes criticized—for its ambitious media campaigns and sometimes confrontational public demonstrations.

Animal rights activists Alex Pacheco and Ingrid Newkirk founded PETA in 1980. The organization's headquarters are in Norfolk, Virginia. PETA also has offices in Germany, India, and the United Kingdom. Helena Silverstein

See also **Animal rights movement.**

Peoria, *pee AWR ee uh* (pop. 112,936; met. area pop. 347,387), is a major industrial center and one of the largest cities in Illinois. It lies in the central part of the state on the Illinois River, about 150 miles (241 kilometers) southwest of Chicago (see **Illinois** [political map]).

Caterpillar Inc., the world's largest maker of earthmoving equipment, has its headquarters in Peoria. The firm is the area's largest employer. Peoria is also the home of the U.S. Department of Agriculture's National Center for Agricultural Utilization Research.

Peoria's Lakeview Center features a museum, planetarium, theater, library, and indoor ice-skating arena. A downtown civic center includes an auditorium, convention hall, and sports arena. RiverFront Peoria, a development along the Illinois River, has parks, sculptures, restaurants, and sports facilities. Deer, elk, and buffalo roam Wildlife Prairie Park, which covers 1,600 acres (647 hectares) west of the city. The Peoria area is the home of Bradley University, Illinois Central College, and a branch of the University of Illinois medical school.

The famous question "Will it play in Peoria?" originated in vaudeville days (see **Vaudeville**). The entertainment industry tested new acts and shows in the city. Peoria later became a test market for consumer products.

The city was named for the Peoria Indians, who originally inhabited the area. The first Europeans to reach the Peoria area were Louis Jolliet, a French-Canadian explorer, and Father Jacques Marquette, a French missionary. They arrived by canoe in 1673. A settlement called Fort Crèvecoeur was established there in 1680. It was soon abandoned but was followed by several other settlements. The town of Peoria was incorporated in 1835.

Peoria has a council-manager form of government. It is the county seat of Peoria County. Jack Brimeyer

Pepin the Short, *PEHP ihn* (714?-768), also called Pepin III, was the first king of the Frankish Carolingian dynasty. The Franks were Germanic peoples who gradually gained control of much of present-day France and Germany and other parts of Western Europe during the early Middle Ages.

In 742, Pepin and his brother Carloman jointly inherited from their father, Charles Martel, the title of Mayor of the Palace. Since the late 600's, mayors had held greater power than the Merovingian kings, who ruled in name only. As mayors, Pepin and Carloman extended Frankish rule to parts of Saxony and Bavaria. After Carloman became a monk in 747, Pepin ruled alone. In 751, with Pope Zachary's help, Pepin deposed the last Merovingian king, Childeric III, and became king of the Franks.

As king, Pepin aided the pope against the Lombards, a Germanic people who had conquered much of Italy. Pepin seized some of the Lombard lands in Italy and gave them to Pope Stephen II in 756. This so-called Donation of Pepin is often seen as forming the core of the Papal States, a territory controlled by the pope until the 1800's. Pepin also added Aquitaine to his kingdom. His son Charlemagne became one of the most powerful rulers in European history. Bernard S. Bachrach

See also **Charlemagne.**

Pepper is a spice that comes from the fruit of several kinds of plants. Black pepper and white pepper are obtained from the fruit of a trailing or climbing vine native to Asia. It was partly the demand for black pepper and other spices that led Christopher Columbus to seek a sea route to Asia, a voyage on which he instead became the first European to visit the New World. Today, most black pepper and white pepper come from Malaysia, India, Indonesia, and other countries with hot climates.

The pepper plant bears a small green berry, which turns red as it ripens. The berries are gathered when they begin to change color. They are cleaned, then dried in the sun or before a fire. In drying, the berries turn black. When they are ground and sifted, they form the black pepper known in most households.

White pepper is made from the ripe berries of the same plant. These are bruised, then washed until the



WORLD BOOK illustration by Kate Lloyd-Jones, Linden Artists Ltd.



Pepper is made from berries of the pepper plant. The plant bears small green berries, which become red as they start to ripen, *above.* At this stage, the berries can be used to make black pepper. White pepper is obtained from fully ripened berries, *right.*

Virginia P. Weinland, Photo Researchers

seeds are free from pulpy matter and bits of stalk. The seeds are then dried. White pepper has a finer flavor than black but is not so strong.

Red pepper comes from types of capsicum, a small plant native to North and South America. Jamaica pepper, also called *allspice,* comes from the pimento tree.

Pepper contains a substance called *piperine* that gives the spice its sharp, biting taste. Pepper also contains a mixture of oils that produce its aroma. David S. Seigler

Scientific classification. Black pepper and white pepper come from a plant in the family Piperaceae. The scientific name for this plant is *Piper nigrum.*

See also **Allspice; Cayenne pepper; Kava; Pepper** (plant).

Pepper is a shrubby plant grown for its fruit, which are also called peppers. The fruit develop from the plant's flowers. The pepper plant probably originated in South America. Early American Indians used pepper as a seasoning. In the late 1400's and the 1500's, European explorers brought pepper from America to Europe and Asia. Today, pepper is grown throughout much of the world. In tropical regions, the pepper plant is a *perennial,* which means it lives for at least two growing seasons. In temperate areas, the plant is an *annual* and lives only one growing season.

Pepper fruit consists of a thick, fleshy wall that surrounds a mass of seeds. The wall is eaten fresh as a vegetable. Fresh peppers can also be dehydrated, pickled, and canned for eating. Pepper fruit is ground up to make the spice known as red pepper. Other seasonings that are made from peppers include curry powders and paprika. The spices black pepper and white pepper are made from another kind of plant (see **Pepper** [the spice]).

Many varieties of peppers are grown commercially. The cup-shaped *bell pepper* has three or four *lobes* (rounded sections) and is usually eaten when immature and green. If allowed to mature on the plant, it turns red, yellow, or purple. Other widely cultivated peppers include the long *banana pepper,* the flattened *pimento pepper,* the slender *chili pepper,* and the round *cherry pepper.* Peppers have either a sweet taste or a sharp taste, depending on the amount of a compound called *capsaicin* in the fruit.



John Colwell from Grant Heilman

The green pepper adds color and flavor to food.

Growers raise peppers from seeds. They generally plant the seeds in a greenhouse or in *cold frames* (glas covered boxes). The seedlings are transplanted outdoors after about 8 weeks. Growers use a mechanical transplanter to place the seedlings in the soil about $1\frac{1}{2}$ feet (46 centimeters) apart and in rows about 3 feet (91 centimeters) apart.

Peppers grow best in warm, moist regions with grow ing seasons of over 125 days. Temperatures under 55 °F (13 °C) can inhibit growth and ripening. Growers occasionally spread plastic mulches or other protective coverings over the soil to warm the plants' environment. This extends the growing season.

Pepper plants flower about three to four weeks after transplanting. The plants commonly grow to a height o $3\frac{1}{4}$ feet (1 meter) or more. Growers sometimes support pepper plants with stakes and string to keep them from spreading along the ground.

Diseases caused by bacteria, fungi, and viruses can a tack pepper plants. Insects also feed on the plant's ster leaves, and fruit. Growers control these problems by planting disease-resistant varieties of peppers and by carefully using appropriate pesticides. Hugh C. Price

Scientific classification. Peppers belong to the nightshade family, Solanaceae. Most peppers are varieties of the species *Capsicum annuum.*

Pepperdine University is a private, coeducational, Christian, liberal arts university in Malibu, California. It also has educational centers in southern California; Lor don; Florence, Italy; and Heidelberg, Germany. The university grants bachelor's, master's, and doctor's degree It was founded in 1937 as George Pepperdine College.

Critically reviewed by Pepperdine University

Peppermint is a perennial herb of the mint family. Farmers grow it for the fragrant oil produced in its leaves. Peppermint oil is a popular flavoring for candy, and it adds a pleasant taste to many medicines, mouthwashes, and toothpastes. Some medicines for toothaches and colic contain peppermint. Menthol, used in medicines for colds and coughs, is made from peppermint oil. It causes a sensation of coolness in the mouth.

The peppermint plant grows 1 to 3 feet (30 to 91 centimeters) high and bears smooth, sharply pointed, oval leaves and small, purplish flowers. The plant grows be in moist soil containing a large amount of decayed plant matter. Peppermint was developed by crossbreeding the water mint and spearmint plants.

Peppermint originated in Europe, and English colonists brought it to North America. Today, most of the peppermint produced in the United States comes from Oregon and Washington. Idaho, Indiana, and Wisconsin also grow it. Peppermint also grows in the United Kingdom and other European



WORLD BOOK illustra by James Teason

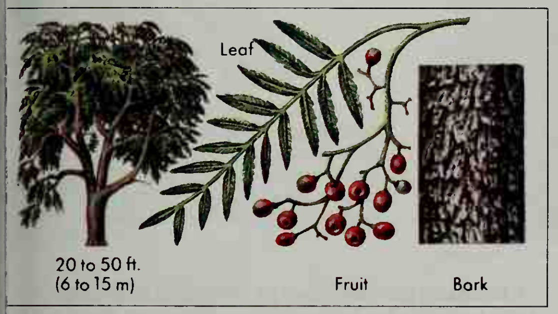
Peppermint

:ountries. The oil is extracted from the peppermint plant)y steam distillation.

Scientific classification. Peppermint belongs to the mint amily, Lamiaceae or Labiatae. Its scientific name is *Mentha X)iperita.* Lyle E. Craker

See also **Menthol; Mint.**

'eppertree gets its name from the strong-smelling)erries that grow on it. The peppertree is not related to he familiar pepper plant. Peppertrees have drooping)ranches and bear yellowish-white flowers. The long eaves are filled with an oil that evaporates quickly. Vhen the leaves are dropped onto still water, the oil es- :apes. The oil lowers the surface tension of the water,



WORLD BOOK illustration by Chris Skilton

'he peppertree gets its name from its strong-smelling red)erries. The tree has drooping branches and long, thin leaves. It rows in warm parts of North and South America.

ınd the leaves move as if alive.

Peppertrees are native to South America, but they are ıow grown in California, Arizona, and Texas. They reach height of about 50 feet (15 meters).

Scientific classification. Peppertrees belong to the cashew ımily, Anacardiaceae. The scientific names for the species rown in the United States are *Schinus molle* and *S. terebinthi-)lius.* Richard A. Jaynes

'epsin is a digestive enzyme found in the gastric juice f the stomach. It changes proteins in food into sub- tances called *peptides.* In chemical composition, pep- in is like other enzymes, but its effects are entirely dif- erent. Its activity is strongest in an acidic environment, uch as that found in the stomach. Pepsin has no effect n fats or carbohydrates. It is produced commercially by rying the mucous lining of the stomachs of pigs and alves. Kermit L. Carraway

See also **Digestive system** (From mouth to stomach); **nzyme; Stomach; Ulcer.**

'eptide. See **Protein** (The structure of proteins); **En- orphin.**

'epys, *peeps, pehps,* or *PEHP ihs,* **Samuel** (1633- 703), was an English writer and government official. His ımous *Diary* provides an intimate self-portrait and a ivid picture of an exciting period in English history. epys also became known for his role in the develop- ıent of the British Navy.

His diary covers the period from 1660 to 1669. It eals with an early part of Pepys's life, when he was erk of the navy. He wrote the *Diary* in a code combina- on of shorthand, foreign words and phrases, and con- actions of his own invention.

Pepys meticulously recorded events of his daily life. He wrote frankly about his affairs with women and his desire to become wealthy. He described his enthusiasm for music and the theater, and his interest in collecting books and paintings. Pepys told of his public career and his pride in his success. The *Diary* documents his curi- osity about everything, from science to the gossip at the court of King Charles II. Pepys did not intend to have the *Diary* read by the public, and he wrote about himself with unusual honesty.

Pepys recorded many of the important events of the 1660's as a witness and participant. The *Diary* colorfully describes the restoration of the king as ruler of England. The work also contains thrilling accounts of the Great Plague, the Great Fire of London, and England's naval war with the Netherlands. In an especially memora- ble entry, Pepys related his court defense of the navy board after the board came under attack by a parlia- mentary committee.



Portrait of Samuel Pepys (1666), an oil painting on canvas by John Hayls; National Portrait Gallery, London

Samuel Pepys

Pepys stopped writing the *Diary* because his vi- sion deteriorated. The work was first translated from 1819 to 1822 and was published in an abridged edition. The unabridged *Diary* was published in nine volumes from 1970 to 1976.

His life. Pepys was born in London and attended Cambridge University. Through the influence of a pow- erful relative, Sir Edward Montagu, he was appointed clerk of the Acts of the Navy in 1660. This post gave Pepys a position on the navy board. His ability, dedica- tion, and industriousness soon made him the most effi- cient administrator in the navy office.

In 1673, Pepys became secretary of the admiralty and thus, in effect, head of the navy. Under Pepys, the navy administration developed into an efficient, professional organization. Pepys introduced numerous reforms on matters ranging from the appointment of naval officers to the maintenance of dockyards. These standards and procedures were important to the foundation of the modern British Civil Service.

Pepys served in Parliament several times, and he was president of the Royal Society in 1684 and 1685 (see **Royal Society**). He lost his post in the admiralty after the fall of King James II in 1688. Pepys then wrote *Mémoires of the Royal Navy, 1679-1688,* which was published in 1690. Gary A. Stringer

Pequod. See **Melville, Herman.**

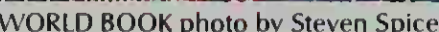
Pequot War. See **Connecticut** (The Pequot War); **Indian wars** (The Pequot War).

Percale, *puhr KAYL,* is a closely woven cloth made from combed cotton yarn. It is used in making dresses, pajamas, shirts, and other clothes.

Percale usually has a colored *print* (design). It has a plain weave and a dull, smooth finish. Fine quality sheets are often called percale. Printed percale is often called *print.* Christine W. Jarvis

Percé Rock. See **Quebec** (Places to visit; picture: Huge Percé Rock).





WORLD BOOK photo by Steven Spicer



WORLD BOOK illustration by Sarah Woodwa

Percentage attracts shoppers because it shows how much a buyer can save on a store's regular prices. A sale at "25% off" means that regular prices have been reduce by $\frac{25}{100}$ or .25 or $\frac{1}{4}$ for a certain period of time.

Percentage refers to computing by hundredths. You often see numbers such as 2%, 30%, and 75%. The % symbol means *percent.* You read the numbers "2 percent," "30 percent," and "75 percent." *Percent* means *hundredths:* 2% means 2 hundredths, 30% means 30 hundredths, and 75% means 75 hundredths. Percentages are really *common fractions:* 2% is $\frac{2}{100}$, 30% is $\frac{30}{100}$, and 75% is $\frac{75}{100}$. In addition, percentages are *decimal fractions:* 2% is .02, 30% is .30, and 75% is .75. Suppose you want to find 25% of 60. You must find $\frac{25}{100}$, or .25, of 60. The term *percent* is from two Latin words meaning *by the hundreds.*

We use percentage frequently in everyday life. Bankers use percentage to compute interest on savings and loans. Our taxes are percentages of income, prices, and other amounts. Scientists often show the results of their observations and experiments with percentages. In baseball, team standings and batting averages are based on percentages. On clothing labels, percentages often represent the amounts of different fibers that are in the garment.

For hundreds of years, the business world has used the term *percent,* and this custom has persisted to the present time. The custom may come from Roman taxes, which were often stated as $\frac{1}{20}$, $\frac{1}{25}$, $\frac{1}{100}$, and so on. In the Middle Ages, merchants commonly used hundredths and percentages even before the appearance of the decimal number system (see **Decimal system**).

After the introduction of the decimal system, people no longer needed to use the term *percent.* It is just as easy to work with .25 as it is to work with 25%. However, percentage had become so deeply woven into business, professional, and everyday life that use of the term continued.

How to change percentages to fractions

Percent, in English, means *hundredths.* To change a percentage to a common or decimal fraction, you need only write the percentage as hundredths.

Changing percentages to common fractions. To change a percentage to a common fraction, drop the % symbol and write in a denominator of 100. Here are fou examples:

$25\% = \frac{25}{100} = \frac{1}{4}$ $\quad$ $37.5\% = \frac{37.5}{100} = \frac{3}{8}$

$125\% = \frac{125}{100} = 1\frac{1}{4}$ $\quad$ $265\% = \frac{265}{100} = 2\frac{13}{20}$

Changing percentages to decimal fractions. To change a percentage to a decimal fraction, drop the % symbol and write in a decimal point two places to the left. Here are four examples:

25%=.25 $\quad$ 37.5%=.375

125%=1.25 $\quad$ 265%=2.65

How to change fractions to percentages

Changing common fractions to percentages. To change a common fraction to a percentage, divide the numerator by the denominator to get a decimal fractior Then move the decimal point two places to the right and attach the % symbol. Here are four examples:

$\frac{3}{5}$ =3÷5=.60 (60 hundredths)=60%

$\frac{5}{8}$ =5÷8=.625 (62.5 hundredths)=62.5%

$\frac{2}{3}$ =2÷3= .66 $\frac{2}{3}$ (66 $\frac{2}{3}$ hundredths)= 66 $\frac{2}{3}$%

$\frac{7}{4}$ =7÷4=1.75 (175 hundredths)=175%

Changing decimal fractions to percentages. To change a decimal fraction to a percentage, move the decimal point two places to the right and attach the % symbol. Here are four examples:

.07 (7 hundredths)=7%

.63 (63 hundredths)=63%

.625 (62.5 hundredths)=62.5%
1.52 (152 hundredths)=152%

Solving percentage problems

Because percent means hundredths, you should re-
tate any percentage problem in terms of decimal or
ommon fractions. Then you can solve it fairly easily as a
raction problem.

How to find a percentage of a number. Suppose
ou want to find 4% of 50. This means you want to find 4
undredths of 50. First, change 4% to a common or deci-
nal fraction.

$$4\% = \frac{4}{100} \qquad 4\% = .04$$

n order to find 4% of 50, you must multiply 50 by the
action that 4% represents:

$$\frac{4}{100} \times 50 = \frac{200}{100} = 2 \qquad .04 \times 50 = 2$$

o 4% of 50 is 2.

Here are some more examples:
ind 30% of 72.

$$30\% = \frac{30}{100} \qquad 30\% = .30$$

$$\frac{30}{100} \times 72 = \frac{2160}{100} = 21.6 \qquad .30 \times 72 = 21.6$$

30% of 72 is 21.6

ind $66\frac{2}{3}$% of 915.

$$66\tfrac{2}{3}\% = \frac{66\frac{2}{3}}{100} = \frac{200}{300} = \frac{2}{3} \qquad 66\tfrac{2}{3}\% = .66\tfrac{2}{3}$$

$$\frac{2}{3} \times 915 = \frac{1830}{3} = 610 \qquad .66\tfrac{2}{3} \times 915 = 610$$

$66\frac{2}{3}$% of 915 is 610

ind 250% of 32.

$$250\% = \frac{250}{100} = \frac{5}{2} \qquad 250\% = 2.5$$

$$\frac{5}{2} \times 32 = 80 \qquad 2.5 \times 32 = 80$$

250% of 32 is 80

What percentage is one number of another? Look
the statement 20 = 4 × 5. The numbers 4 and 5 are
ctors of 20. When you multiply these factors, you get
e product 20. Suppose the factor 5 is missing: 20 = 4
?. You can find the missing factor by dividing 20 by 4:
) ÷ 4 = 5. Suppose the factor 4 is missing from the
atement: 20 = ? × 5. You can find it the same way: 20 ÷
= 4.

Now suppose one of the factors is a fraction. Look
refully at the problem 30 = ? × $\frac{1}{4}$. You can find the
issing factor by dividing 30 by $\frac{1}{4}$:

$$30 \div \frac{1}{4} = 30 \times \frac{4}{1} = 120$$

) 30 = 120 × $\frac{1}{4}$. Percentages are hundredths, so you
n use this process to find what percentage one num-
r is of another.

Suppose you want to find what percentage of 30 the
mber 15 is. First, write the problem in the form 15= ?
30. You can find the missing factor by dividing 15 by
:

$$15 \div 30 = .5 \qquad .5 = 50\%$$

15 is 50% of 30.

Here are two more examples:
17 is what percentage of 340?

$$17 = ? \times 340$$
$$17 \div 340 = .05 \qquad .05 = 5\%$$

17 is 5% of 340

420 is what percentage of 70?

$$420 = ? + 70$$
$$420 \div 70 = 6 \qquad 6 = 600\%$$

420 is 600% of 70

These problems can also be solved by comparing ra-
tios. For example, in determining what percentage of 30
the number 15 is, you are attempting to find a number
that compares to 100 in the same way that 15 compares
to 30. That is, you are looking for the number that, with
100, expresses the same ratio as the ratio of 15 to 30:

$$\frac{15}{30} = \frac{?}{100} \qquad 15 \times 100 = 30 \times ? \qquad \frac{1500}{30} = 50$$

So 15 is 50% of 30.

Finding a number when a percentage is known.
Suppose you know that 6 is 25% of some number. What
is the number? You can use the process of finding a
missing factor to solve this problem. First, write the
problem in the form 6 = 25% × ?. Now 25% is .25, so the
problem becomes 6 = .25 × ?. You can find the missing
factor by dividing 6 by .25:

$$6 \div .25 = 24$$

So 6 is 25% of 24.

Here are some more examples:
17 is 40% of what number?

$$17 = .40 \times ? \qquad 17 \div .40 = 42.5$$

17 is 40% of 42.5

46 is 115% of what number?

$$46 = 1.15 \times ? \qquad 46 \div 1.15 = 40$$

46 is 115% of 40

Applications of percentage

Commissions. Many companies pay their salespeo-
ple by giving them a *commission* (a certain amount of
money for each article they sell). The commission is usu-
ally a certain percentage of the price of the article that is
sold.

Suppose a salesman receives a 15 percent commis-
sion on everything he sells. How much money does the
salesman earn if he sells a refrigerator for $749? That is,
what is 15 percent of $749? First, remember that 15 per-
cent means 15 hundredths. You must find .15, or $\frac{15}{100}$, of
749.

$$15\% = \frac{15}{100} \qquad 15\% = .15$$

$$\frac{15}{100} \times \$749 = \$112.35 \qquad .15 \times \$749 = \$112.35$$

So the salesman earns $112.35 on the sale.

Comparisons. Percentage gives us a method of com-
paring quantities. It helps to make a comparison where
the relationship is not easy to see at once. For example,
percentage helps people to compare volumes of sales
on the stock market. Companies often use percentage to
compare their business gains and losses. Engineers use
percentage to compare production rates with their

goals. Here is a more familiar example taken from the records of three baseball teams:

Boston Red Sox won 12 games and lost 8 games.
Toronto Blue Jays won 13 games and lost 9 games.
New York Yankees won 11 games and lost 6 games.

What is the correct standing of the teams?

To determine standing, you can compare the number of games won by each team to the number of games that team has played. First, you can see that the Boston Red Sox played 20 games and won 12 of them. What percentage of 20 is 12? Remember the process of finding a missing factor.

$$12 = ? \times 20$$
$$12 \div 20 = .60 \qquad .60 = 60\%$$

So the Boston team won 60 percent of its games.

The Toronto Blue Jays played 22 games and won 13 of them. What percentage of 22 is 13?

$$13 = ? \times 22$$
$$13 \div 22 = .591 \qquad .591 = 59.1\%$$

The Toronto team won 59.1 percent of its games.

The New York Yankees played 17 games and won 11 of them. What percentage of 17 is 11?

$$11 = ? \times 17$$
$$11 \div 17 = .647 \qquad .647 = 64.7\%$$

The New York team won 64.7 percent of its games.

Now you can arrange the teams on the basis of the percentage of games won:

Team	Percentage
New York Yankees	64.7
Boston Red Sox	60
Toronto Blue Jays	59.1

You can use percentage to compare other quantities.

Interest. When people borrow money from a bank, the bank charges them *interest* on the loan. Paying interest is like paying rent for the use of the money. Bankers usually compute interest by percentage.

Suppose a businesswoman borrows $6,000 from the bank. The bank charges her 9 percent interest a year. How much interest does she have to pay every month? First, what is 9 percent of $6,000?

$$9\% = .09$$
$$.09 \times \$6{,}000 = \$540 \qquad 9\% \text{ of } \$6{,}000 = \$540$$

So the businesswoman must pay the bank $540 on her loan for one year. To find how much she must pay for one month, divide $540 by 12:

$$\$540 \div 12 = \$45$$

So the businesswoman must pay the bank $45 every month as interest on her loan. See **Interest**.

Profits. Businesses usually charge a price for an article that includes the article's cost and the company's own profit. This price is the *selling price*. Businesses usually compute their profits as percentages.

Suppose a dealer bought a bicycle from a manufacturer for $360. The dealer wants to make a profit of 25 percent of the price for which the bicycle is sold. How much must the dealer charge for the bicycle and what will the profit be? To make a profit of 25 percent, the cost of the bicycle from the manufacturer must be 75 percent of the price the dealer charges. So the problem is to find the number of which $360 is 75 percent. Remember the process of finding a missing factor.

$$75\% = .75$$
$$\$360 = ? \times .75$$
$$\$360 \div .75 = \$480 \qquad \$480 - \$360 = \$120$$

So the dealer must charge $480 for the bicycle. The profit will be $120. As a check, you can see that the profit, $120, is 25 percent (or one-fourth) of the selling price of $480.

Taxes. A large number of prices include taxes. For example, the price of a bracelet could include both federal and state tax charges. These taxes are usually computed as percentages of an article's price before the tax was added.

Suppose a college sells tickets for a football game. Each ticket costs $30. The $30 price includes a 10 percent federal tax on the college's income from the ticket. What is the income from each ticket? If the $30 price includes both income and the 10 percent tax, then the $30 must represent 110 percent of the income. So the problem is to find the number of which $30 is 110 percent.

$$110\% = 1.10$$
$$\$30 = ? \times 1.10$$
$$\$30 \div 1.10 = \$27.27 \textit{ (to the nearest cent)}$$

So the income that the college earns from each ticket sold is $27.27. Nadine L. Verderber

See also **Decimal system; Fraction; Graph; Statistics.**

Perception is the process by which we observe and find meaning in the objects, events, and people around us. Our knowledge of the world comes through our sense organs, which react to various kinds of energy and physical signals. Our eyes respond to certain wavelengths of light. Our ears sense certain kinds of vibrations in the air. Our noses and tongues are sensitive to certain chemical signals. Sense organs in our skin respond to pressure, temperature, and pain. Sense organs in our joints, tendons, and muscles respond to body movement and position.

Sense organs change the various physical signals into nervous impulses, and these impulses then travel to the brain. Through the psychological process of perception, the patterns of signals come to exist in our minds as objects, events, people, and other aspects of the world.

Perception involves an active process of "working on" sensory data to produce objects and events. This "work" involves many physical and psychological factors. For example, there is no music or noise in the vibrations that stimulate the ear. The brain organizes and interprets nervous impulses from the ears as sound. Together, the sense organs and the brain transform physical energy from sound waves and other environmental stimuli into information about the events around us.

Factors affecting perception

Both physical and psychological factors influence perception. One of the most important physical factors is the structure of the human nervous system. Important

ɪsychological factors include our emotions, needs, ex-
ɪectations, and learning.

The nervous system. Each sensory system, such as
ision, hearing, or touch, has its own specialized detec-
ors. These detectors are called *receptors,* and they
unction in various ways to change energy into nervous
npulses. For example, the human eye has two major
inds of receptors in the *retina* (the light-sensitive part of
he eye). These receptors are called *rods* and *cones.*
ods and cones each contain particular chemicals that
espond to light in different ways. As a result, rods de-
ect shape, movement, and shades of gray, but do not
espond to other colors. Cones, however, detect the full
ange of color by responding to different frequencies of
ght. These differences in structure and function help
etermine the perceptual effects related to rods and
ones. Rods enable us to see in dim light, and cones en-
ble us to see colors and sharp detail in bright light.

The brain. Certain physical and functional features of
ne brain also influence perception. The part of the brain
nat interprets visual signals has different kinds of cells
nat respond only under certain conditions. Some of
nese cells respond when a light is lit, but they stop re-
ponding if the light stays on. Others respond only
/hen a light turns off. These cells also are arranged in
pecial ways that are related to how we perceive. For ex-
mple, some cells occur in columns or in clusters that
re related to how we perceive edges and forms.

Learning, emotion, and motivation. Much evi-
ence supports the conclusion that learning, emotion,
nd motivation are important influences on perception.
art of this evidence comes from experiments that com-
are how people in different cultures perceive things.
he perception of form, color, pain, touch, and other ex-
eriences may differ from culture to culture, depending
n habits, customs, and training of children.

Look at the illustration of perceptual effects in this ar-
cle for a simple example of how learning can affect
erception. Read the phrases inside the two triangles at
ie top of the picture. Did you fail to see the duplicate
ords? Most people do, and many experienced readers
ɔntinue to miss the duplicate word even with repeated
eadings. In learning to read, we learn not to perceive
ich letter and word separately. As our skill improves,
e become increasingly able to scan the overall pattern
ıd "fill in" the rest. This tendency to notice overall
eaning increases the chance that an experienced read-
will overlook the duplicated word in each phrase. A
ader who still reads word by word is more likely than
ı advanced reader to see the repeated word.

Visual effects called *illusions* can also demonstrate
e influence of learning and past experience. An illu-
ɔn is not a false perception, as many people believe,
ıt one that is inconsistent with another perception.
ɪok at the two triangular patches of gray containing
ack and white detail in the illustration of perceptual ef-
cts. If you see the patches as being different shades of
ay, then you are experiencing an illusion. The patches
e the same shade of gray.

Emotions and motivation can have important effects
ı perception. At times, severe emotional disturbance
n prevent perception completely. For example, some
ople who are robbed are unable to remember any-
ng about the appearance of the robber. Motivation
can also affect the way we perceive. For example, food
may seem unusually large or colorful to hungry people.

Understanding perception

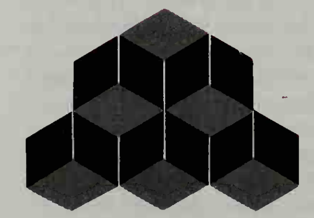
Types of perception. Perception has three levels of
complexity: (1) *detection,* (2) *recognition,* and (3) *discrimi-
nation.* Detection refers to whether people can sense
that they are being stimulated by some form of energy.
For example, a light may be so dim that people can
barely see it. Recognition means being able to identify
as well as detect a particular pattern of stimulation. Dis-
crimination means being able to perceive patterns of
stimulation as different. For example, a person may

Perceptual effects

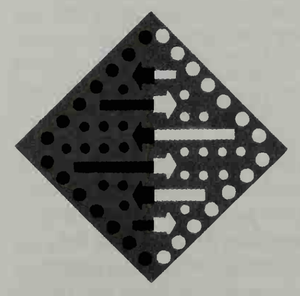
PARIS
IN THE
THE SPRING

ONCE
UPON A
A TIME

What are the two phrases printed in the two triangles above? Read them carefully. Did you read them correctly the first time?



How many complete cubes do you see in the drawing at the left? Three or five?



How do the two gray triangles at the left compare in brightness? In the drawings below, does the word *World* in the black rectangle appear brighter than the word *Book* in the white rectangle? The text of this article discusses each of the perceptual effects shown here.

William M. Smith





hear slight differences between two similar musical tones.

The field of study that deals with the levels of perception is called *psychophysics.* Psychologists investigate relationships between the physical properties of stimulus patterns and the perceived effects of the stimuli. For example, they may study the relationship between sound frequency and the perceived pitch of the sound.

Principles of perception. There are a number of general principles that help us understand the process of perception. One of the most important of these principles is the idea of *closure.* Closure is the general psychological tendency to perceive things as complete and unified. We tend to "fill in" parts that are missing, or parts that conform to an overall impression.

The principle of *constancy* states that we tend to perceive objects as constant in size, shape, color, and other qualities in spite of changes that occur in stimulation. For example, an orange will be perceived to have its characteristic color under different kinds of light. The opposite of the principle of constancy is also important. Sometimes an object or pattern of stimulation will remain constant, but the perceived effect will vary. For example, look at the gray and black cubes in the illustration of perceptual effects. At one moment you may see three complete cubes, but at another moment you may see five.

Another important principle relates to *perceptual context.* The perception of an object or event depends in part on the *context* (surrounding conditions). Look at the two rectangles containing the words *World Book* in the illustration. The words are printed with the same ink. Do they look the same? Background intensity and color may affect the color and intensity of elements upon it. To most people, the letters surrounded by black appear brighter and somewhat larger than the letters surrounded by gray. This effect is called *visual induction.* Notice, too, that the effect is opposite to that observed with the two gray triangles with black and white detail. In this case, the gray with black detail appears darker rather than brighter. William M. Smith

Related articles in *World Book* include:

Color (How we see color)	Learning disabilities
Ear (The sense of hearing)	Nervous system
Eye (How we see)	Optical illusion
Gestalt psychology	Senses

Perch is the name of a family of about 165 species of freshwater fish that live in the Northern Hemisphere. The larger species, such as the *yellow perch, walleye,* and *sauger,* are popular game fish. About 150 of the smaller species in the perch family belong to a group called *darters.* Perch are in the group of bony fish called *teleosts,* to which most common fish belong.

The name *perch* is most commonly given to the yellow perch of North America. This golden-yellow fish is also called the *ringed perch* and *common perch.* It grows from 5 to 12 inches (13 to 30 centimeters) long and weighs up to 4 pounds (1.8 kilograms). Its sides are marked with several dark bars. The yellow perch is an important food fish. It ranges from the Chesapeake Bay region northward into Canada and also throughout the upper Mississippi River basin. A similar species is common in Europe.

The walleye measures 12 to 36 inches (30 to 90 centimeters) long and weighs up to 24 pounds (11 kilograms). The sauger grows to 28 inches (71 centimeters) long and weighs about 9 pounds (4.1 kilograms). Both species inhabit the Great Lakes and lakes, rivers, and streams throughout the Mississippi River basin and into Canada. The walleye is also known as the *pike, pickerel, walleyed pike, pike perch,* and *jack salmon.*

Darters are found only in North America. Males are brightly colored, especially during the breeding season. The *least darter* measures from 1 to 1 $\frac{1}{4}$ inches (2.5 to 3.0 centimeters) long and weighs about $\frac{1}{30}$ ounce (1 gram). It is the smallest fish in the perch family. See **Darter**.

The *bluegill, longear sunfish,* and *pumpkinseed* are sometimes referred to as perch. But they are actually in the sunfish family. Charles H. Hocutt

Scientific classification. Perch are in the freshwater perch family, Percidae. The yellow perch is *Perca flavescens.* The walleye is *Stizostedion vitreum vitreum* and the sauger, *S. canadense.* The least darter is *Etheostoma microperca.*

See also **Climbing perch**; **Fish** (pictures: Fish of temperate fresh waters; External anatomy).

Percussion instrument. See Music (Musical instruments); **Orchestra**.

Peregrine falcon, *PEHR uh grihn,* is a bird of prey that can travel faster than any other animal. It makes *stoops* (steep dives) that may exceed 200 miles (320 kilometers) per hour. Peregrines, sometimes called *duck hawks,* are also among the most widely distributed birds. They live on every continent except Antarctica.

Peregrine falcons grow about 15 to 20 inches (38 to 51 centimeters) long. Females are about a third larger than males. Peregrines vary in color from brownish when young to dark blue or bluish-gray when mature. The bird's underside is lighter in color, and dark markings occur all over the body. A black, helmetlike crown of feathers covers the male peregrine's head and neck.

Peregrines prefer to nest on high cliffs or even ledges of skyscrapers. The females usually lay three or four eggs each year.

Peregrines chiefly eat live birds. They swoop down on their prey from great heights and knock it from the sky. Peregrines may hunt birds as large as geese, but they prefer smaller prey, such as pigeons and ducks.

People have used peregrines as hunting birds for centuries. In the late 1940's and the 1950's, the peregrine population declined dramatically due to harmful pesticides. These pesticides caused thinning of peregrine egg shells, which killed the young before they hatched. By 1960, peregrines had vanished from most of North America. But beginning in the 1970's, pesticide restrictions and other measures led to the birds' gradual recovery. Charles van Riper III and Sandra van Riper

Scientific classification. The peregrine falcon belongs to the falcon family, Falconidae. It is *Falco peregrinus.*

See also **Falcon** (pictures).

Perelman, *PURL muhn,* **S. J.** (1904-1979), was an American writer known for his humorous satires and parodies on contemporary life. Perelman's targets included advertising, best-selling fiction, the Hollywood motion picture industry, and the behavior of American tourists when they visited other countries.

Sidney Joseph Perelman was born in the Brooklyn section of New York City. He grew up in Providence, Rhode Island, the setting of several of his works. Follo

ıg the success of his first book, *Dawn Ginsbergh's Re-enge* (1929), he went to Hollywood to write screen-lays. He helped write the scripts for two of the Marx rothers' best-known comedies, *Monkey Business* (1931) nd *Horse Feathers* (1932). From 1931 until his death on)ct. 17, 1979, much of his work appeared in *The New orker* magazine. His selected letters were published in *)on't Tread on Me* (1986). Samuel Chase Coale

'erennial, *puh REHN ee uhl,* is a plant that lives for ıore than two years or growing seasons. Some peren-ials, such as trees, can live for hundreds of years. erennials differ from *annuals,* which complete their life ycles in a single year, and from *biennials,* which live vo years or growing seasons. See **Annual; Biennial.**

Perennials are either *woody* or *herbaceous* (non-'oody). Woody perennials, which include trees and ırubs, develop stems that increase in diameter each rowing season. They do this by adding new tissues, ıostly wood, to those of previous seasons. The above-round parts of herbaceous perennials die each season, ut the underground parts produce new shoots the next ear. Herbaceous perennials include asparagus, rhu-arb, and many spring wildflowers. Joseph E. Armstrong

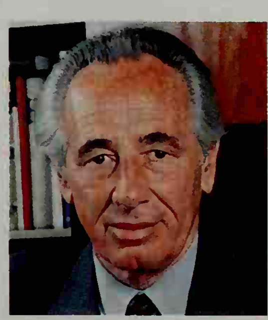
See also **Flower** (Garden perennials).

eres, *PEH rehs,* **Shimon,** *shih MOHN* (1923-), a ıbor Party politician, was prime minister of Israel twice. e first held that office from 1984 to 1986. He became ime minister again in 1995 following the assassination Prime Minister Yitzhak Rabin. In 1996, Peres lost in na-ɔnal elections, and Benjamin Netanyahu of the Likud oc replaced him as prime minister.

In the early and middle 1990's, both as foreign minis-r under Rabin and as prime minister himself, Peres ayed a major role in a move for peace between Israel ıd the Palestine Liberation Organization (PLO). Peres, ıbin, and PLO leader Yasir Arafat shared the 1994 No-el Peace Prize for their peace efforts.

Peres served as prime minister in the unity govern-ent created by the Labor Party and Likud in September 984. The parties formed the government after no party on a majority in parliamentary elections. The unity gov-nment lasted for 50 months. Under the agreement be-een Labor and Likud, Peres—head of the Labor Party—rved as prime minister for 25 months. Yitzhak Shamir, ad of Likud, was vice prime minister and foreign min-er. Under the agreement, Peres and Shamir reversed les after 25 months—in October 1986. As prime minis-r, Peres pledged to withdraw Israeli troops that had in-ded Lebanon in 1982. In 1985, the Israeli forces with-ew from all of Lebanon cept a Security Zone ɔng the Israeli border.

In 1988, Labor and Likud rmed a new coalition vernment with Shamir prime minister. Peres re-ıined as vice prime min-er and also became fi-nce minister. In 1990, the alition collapsed, and res resigned from his sts as vice prime minis- and finance minister. ud and small parties formed a new coalition government in June with Shamir as prime minister. Peres had become head of the Labor Party in 1977. In 1992, he lost that post in a party election.


Consulate General of Israel
Shimon Peres

Peres was born on Aug. 16, 1923, in Vishnevo, a small town near Minsk, that was then part of Poland and is now part of Belarus. His family name was Persky. He changed the name to Peres in the 1940's. Peres moved with his family to Palestine in 1934. He later became active in the movement that resulted in the creation of the nation of Israel in Palestine in 1948. In 1950, Peres was sent to the United States as leader of a defense ministry delegation. He returned to Israel in 1952. Peres was first elected to the Israeli *Knesset* (parliament) in 1959. He helped form the Labor Party in 1968. He was minister of defense from 1974 to 1977. He served as foreign minister in 1987 and 1988 and from 1992 until 1995. In 2001, he again became foreign minister. Malcolm C. Peck

Pérez de Cuéllar, *PEH rehs deh KWAY yahr,* **Javier,** *hah vee AIR* (1920-), is a diplomat from Peru who served as secretary-general of the United Nations (UN) from 1982 to 1991. He was the UN's fifth secretary-general and its first from Latin America. Pérez de Cuéllar worked to improve the UN's administrative efficiency. He also took part in negotiations on conflicts in Afghanistan, Central America, Cyprus, the Falkland Islands, and the Persian Gulf. In 1988, he helped negotiate a truce between Iran and Iraq. In 1991, he led talks that resulted in a treaty ending a civil war in El Salvador.

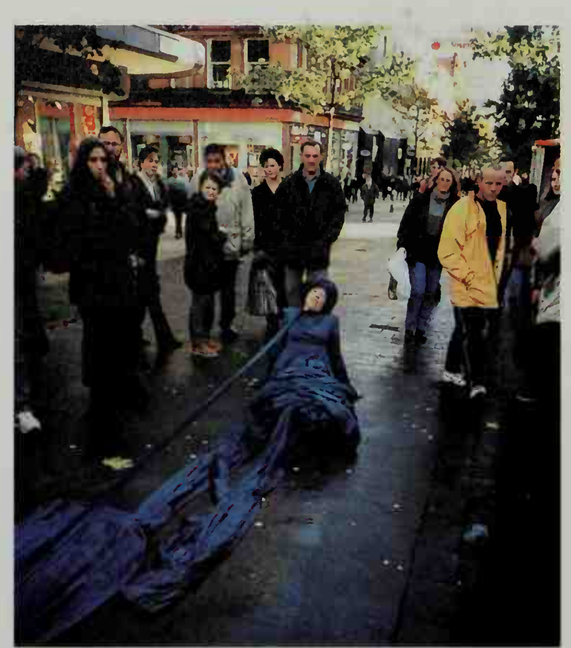
Pérez de Cuéllar was born in Lima, Peru, on Jan. 19, 1920. He received a law degree at the Catholic University in Lima in 1943 and entered Peru's foreign service in 1944. He was Peru's ambassador to Switzerland, Venezuela, and the Soviet Union and, in 1971, became Peru's delegate to the UN. Pérez de Cuéllar served as prime minister of Peru for several months in 2000 and 2001. In 2001, he became Peru's ambassador to France and representative to UNESCO. Michael J. Berlin

See also **United Nations** (picture).

Performance art is a live performance that combines elements from many branches of art. Performance artists use literature, the visual arts, popular culture, music, dance, and theater, as well as video, slides, and computer-generated images. A performance can consist of one person or several and may take place anywhere and last for any length of time. It often uses the performer's body as the primary art medium. It may be autobiographical or make a political statement, especially of a radical nature. Performances often merge art with daily activities.

Performance art grew out of *avant-garde* (experimental) art movements of the early 1900's, particularly Dada and Futurism and the work of the French artist Marcel Duchamp. From the 1940's through the 1960's, these international movements were linked with such American movements as Abstract Expressionism, Minimalism, Pop Art, and Conceptual Art. Artists who pioneered the performance movement in America include composer John Cage, painter and sculptor Allan Kaprow, and sculptor Claes Oldenburg. During the 1960's, all three artists created a form of performance art called *happenings.* Happenings combined sound and visual material in random ways, often with the audience participating.

During the late 1900's, performance art became more concerned with social and political issues, such as feminism or AIDS awareness. Leading performance artists



"Site Unseen" (1998), a performance by Julie Laffin, Glasgow, Scotland, from "Streetworks Festival of Live Art." © Steve Bottoms

Performance art often takes place in a public place. This artist is using the huge train on her dress to symbolize what she sees as the uncomfortable position of women in modern society.

include Laurie Anderson, Spalding Gray, Holly Hughes, and Carolee Schneemann. Don B. Wilmeth

Perfume is a substance that gives off a pleasing fragrance. Perfumes are made of natural or *synthetic* (artificially created) materials, or a combination of both. People who make perfumes are called *perfumers.*

People use perfumes in many ways to create a pleasant odor. They apply paste and liquid perfumes to their bodies and clothing. They use lipsticks, face and body lotions and powders, and other cosmetics that contain perfume. By far the largest amount of perfume is used in soaps, especially bar soaps. Industrial *odorants* (low-priced, scented substances) are added to some products to hide unpleasant odors and make the products attractive to buyers. Paper, plastic, and rubber products are often treated with odorants. Since ancient times, plants and plant products with pleasing odors have been burned as incense during religious services.

All liquids used for body scenting, including colognes and toilet waters, are sometimes considered perfumes. But *true perfumes*—called *extracts* or *essences*—have a greater amount of perfume oils and are more expensive than colognes and toilet waters. Most perfumes consist of 10 to 20 percent perfume oils dissolved in alcohol. Colognes contain 3 to 5 percent perfume oils dissolved in 80 to 90 percent alcohol, with water making up the balance. Toilet waters have about 2 percent of perfume oils in 60 to 80 percent alcohol, and the balance is water.

How perfumes are made

The composition of a perfume depends largely on its intended use. Most expensive body perfumes contain rare flower oils from many parts of the world. Perfumes used in soapmaking come from low-cost materials. Industrial odorants also consist mainly of low-cost fragrances. Many perfumes are blends of flower and plant oils, animal substances, synthetics, alcohol, and water.

Source of materials used in one French-type perfume

Odors	Source
Floral odors	
Jasmine (natural)	Flowers
Jasmine (synthetic)	Coal tar
Violet (natural)	Flowers' leaves
Violet (synthetic)	Oil of lemongrass
Rose (natural)	Flowers
Rose (synthetic)	Coal tar
Lily of the valley (synthetic)	Oil of citronella
Carnation (synthetic)	Oil of cloves
Orange blossom (natural)	Blossoms
Mimosa (natural)	Flowers
Oriental odors	
Sandalwood (natural)	Wood
Vetiver (natural)	Roots
Styrax (natural)	Resin
Patchouli (natural)	Leaves
Odors added to modify the odor of the perfume	
Coumarin (synthetic)	Coal tar
Oak moss (natural)	Moss
Ylang-ylang (natural)	Flowers
Fixative and diluting agent	
Musk ambrette (synthetic)	Coal tar
Alcohol (natural)	Molasses or grain

Plant substances. The substances that give fragrant plants their pleasant odor are called *essential oils.* Essential oils taken from flower petals are used in the most delicate and expensive perfumes. Essential oils also come from bark, buds, leaves, rinds, roots, and wood, or from whole plants. Plant oils used in perfumes include citronella, geranium, jasmine, lavender, patchouli, rose, rosemary, sandalwood, and tuberose.

Much essential oil is *extracted* (obtained) from plants by *steam distillation.* The first step in this process is to pass steam through the plant material. The essential oil turns to gas, which is then passed through tubing and cooled to make it liquid again. Essential oil is obtained from some flowers by boiling the petals in water.

Solvent extraction is an important way of obtaining essential oils from flowers. The petals are dissolved in a *solvent* (liquid that can dissolve other substances). The solvent is distilled from the solution, leaving a waxy material that contains the oil. This material is placed in ethyl alcohol. The oil dissolves in the alcohol and rises with it to the top of the wax. Heat is applied, and the alcohol evaporates, leaving concentrated perfume oil.

Enfleurage is another method of extracting flower oil. Glass plates are covered with fat, and flower petals are spread over the fat. The fat absorbs the oil from the petals, forming a greasy *pomade.* The pomade is treated with alcohol to dissolve out the oil.

Animal substances slow the evaporation of perfume oils and make the fragrances long-lasting. For this reason, they are often called *fixatives.* Perfume ingredients from animals include castor, from the beaver; civet musk, from the civet; musk, from the male musk deer; and ambergris, from the sperm whale.

Synthetic substances account for the largest
mount of materials used in the perfume industry. The
aw materials for these substances may be obtained
om natural sources, petrochemicals, or coal tar. Some
ynthetic materials have the same chemical makeup as
aturally occurring materials. Others are different from
ny material found in nature. Many synthetic odors have
een developed throughout the world to meet the in-
reasing demand for perfumes and to add to the cre-
tive development of the perfume industry.

History

Ancient peoples burned fragrant resins, gums, and
oods as incense at their religious ceremonies. The
ord *perfume* comes from the Latin words *per,* mean-
ıg *through,* and *fumus,* meaning *smoke.*

Perfumes have been found in the tombs of Egyptian
haraohs (rulers) who lived more than 3,000 years ago.
he Egyptians soaked fragrant woods and resins in
ater and oil, and then rubbed their bodies with the liq-
d. They also *embalmed* (preserved) their dead with
ıese liquids. The ancient Greeks and Romans learned
bout perfumes from the Egyptians.

For hundreds of years, perfume making was chiefly
ı Oriental art. In the early 1200's, the crusaders brought
erfume from Palestine to England and France. By the
500's, perfumes had become popular throughout Eu-
ope. Synthetic chemicals have been used extensively in
erfumes since the late 1800's. Today, the perfume in-
ustry is a billion-dollar-a-year business in the United
ates. Patricia Ann Mullen

Related articles in *World Book* include:

nbergris	Flower	Frankin-	Orrisroot	Rose water
tar	(picture:	cense	Patchouli	Rosemary
tronella	Per-	Musk	Petitgrain	Tuberose
vet	fumes)	Myrrh	oil	
tract				

ergolesi, *pehr gaw LEH zee,* **Giovanni Battista,**
h VAHN nee baht TEES tah (1710-1736), was an Italian
mposer. In his time, short comic operas called *inter-
ezzi* were performed between the acts of serious op-
as. Pergolesi was among the first composers to write
mic operas in local dialect. His most significant work,
e short comic opera *La serva padrona,* was first per-
rmed between the acts of his serious opera *Il prig-
ner superbo* (1733).

Pergolesi was born in what is now Iesi and studied
usic in Naples. He composed many religious works.
e most famous one is *Stabat Mater* (1729?). He died of
berculosis at the age of 26. Thomas Bauman

See also **Opera** (Opera seria and opera buffa).

ericles, *PEHR uh KLEEZ* (490?-429 B.C.), was a Greek
tesman whose name was given to the greatest period
the history of ancient Athens. He was the leader of the
henian government for more than 30 years, and the
e of Pericles came to stand for all that was highest in
art and science of the ancient world.

Pericles was born in Athens, a member of a high-
king noble family. He was educated by the greatest
ilosophers of his day. His mother was a niece of Cleis-
nes, a statesman who had made many democratic re-
ms in the Athenian government (see **Cleisthenes**).
isthenes had given the governing power to the as-
nbly and popular courts. But because officials then
received no pay, the poor could not afford to hold of-
fice. After Cleisthenes' death, the *Areopagus,* a council
of prominent citizens, took back its power over the city.

Pericles was determined to continue the reforms of
his great-uncle and entered politics with the democratic
popular party. He and Ephialtes, the leader of this party,
worked to limit the power of the Areopagus. But Cimon,
leader of the aristocratic party, opposed Pericles. Peri-
cles managed to have his rival *ostracized* (banished) for
favoring the Spartans.

Athenian leader. In about 460 B.C., Ephialtes was
killed. Pericles became leader of the popular party and
the most powerful person in the state. He made many
changes as head of the state. Public officials had never
been paid before, but Pericles introduced salaries, first
for the elected officials called *archons,* and later for all
officers. According to Aristotle's *Constitution of Athens,*
as many as 20,000 people were on the public payroll. In
457 B.C., Pericles made his greatest reform. The com-
mon people were allowed to serve in any state office.

Pericles wanted to make Athens the most powerful
state in Greece. He tried to expand the power of Athens
by foreign conquest. Athenian troops fought in Egypt,
Boeotia, and the Aegean Islands. This angered Sparta,
and the two states broke off friendly relations.

War with Sparta. Pericles' wars were not all success-
ful, and Cimon was allowed to return from exile to lead
the armies. Cimon fought successfully against Persia,
and Athens made a favorable peace with that country in
449 B.C. Three years later, Athens signed a 30 years'
peace treaty with Sparta allowing Athens to keep Ae-
gina, Euboea, and the cities of the Delian League. But
Pericles feared there could be no peace with Sparta, for
the Spartans were jealous of Athenian power.

The Athenians had moved the treasury of the Delian
League from Delos to Athens during the war with Persia.
Pericles persuaded the Athenians to use this money and
the money paid by the subject states to build up the
Athenian navy and to beautify Athens. He employed the
finest architects and sculptors to build and decorate the
temple of Athena Nike, the Propylaea, the Parthenon,
and many other structures. The state enjoyed prosperity,
and literature and philosophy flourished.

The Peloponnesian confederacy, headed by Sparta,
declared war on Athens in 431 B.C. Pericles persuaded
the Athenians to adopt a new and difficult strategy. He
called all the people of the surrounding districts into the
city and allowed the Spartans and their allies to lay
waste to the surrounding districts as they pleased. Peri-
cles continued to build up the navy with the hope that
Athens could defeat the Spartans with sea power. In 430
B.C., a plague broke out in the city, and many people
died. The Athenians began to blame Pericles for all their
troubles, and for a short while removed him from
power. But he was soon restored to office. Pericles died
of the plague during the war. Donald Kagan

See also **Athens** (The Acropolis and its buildings);
Parthenon; Peloponnesian War; Sparta.

Peridot, *PEHR uh daht,* is a transparent gem that is al-
most always some shade of green because of its iron
content. Peridots are a variety of a common rock-
forming mineral called *olivine.* Jewelers cut and polish
the highest-quality peridot stones so that each gem has
many flat surfaces called *facets.* Faceted peridots are

used in all types of fine jewelry. Jewelers cut lesser-quality peridots into a rounded style called *cabochon,* or polish them with abrasives in a process called *tumbling.* These lesser-quality peridots are used in costume jewelry and decorative objects. Peridot is one of the two birthstones for August.

Peridots have been known since Biblical times. The earliest source of peridots was Jazirat Zabarjad (St. John's Island), off the Egyptian coast in the Red Sea. In the United States, Arizona and New Mexico are important commercial sources of peridots. Pansy D. Kraus

See also **Gem** (picture).

Perigee. See **Orbit.**

Perihelion, *PEHR uh HEE lee uhn,* is the position of a planet or comet when it is closest to the sun. In the Northern Hemisphere, the earth is at perihelion at midwinter. At this time, the sun shows a larger diameter, but this difference is only 1.7 percent of the sun's average size. A person cannot see the difference without instruments. When a planet or comet's distance from the sun is greatest, it is at *aphelion.* Lee J. Rickard

Period, in geology. See **Earth** (How Earth moves).

Period, in punctuation. See **Punctuation.**

Period, Menstrual. See **Menstruation.**

Periodic table, also called *periodic chart.* See **Element, Chemical; Mendeleev, Dmitri I.**

Periodical. See **Magazine; Trade publication.**

Periodontitis, *PEHR ee oh dahn TY tihs,* is a disease of the gums and of the bone that supports the teeth in their sockets. Periodontitis, also called *pyorrhea alveolaris,* is the chief cause of tooth loss after age 35.

The most common form of periodontitis results from the build-up of *plaque* on the teeth and gums. Plaque is a sticky mixture of food particles and bacteria. The bacteria and their waste products irritate the gums and produce *gingivitis,* an inflammation of the gums (see **Teeth** [Periodontal diseases]). If gingivitis is not treated, the gums become swollen and bleed easily, and in time they may recede from the teeth. The bacteria then attack the connective fibers that line the teeth sockets, and pus forms in the narrow pockets between the teeth. The spreading infection destroys the fibers and surrounding bone that hold the teeth in their sockets. As periodontitis progresses, the teeth become loose and may fall out of their sockets.

Periodontitis is curable in its early stages. A dentist should be consulted if the gums are red and tender and bleed easily. Certain drugs may be prescribed in the initial treatment of the disease. Later treatment consists largely of removing plaque, grinding off rough surfaces of the teeth, surgically removing the diseased gums, and reshaping bone. Proper dental care, including daily brushing and flossing, helps prevent the disease.

John P. Wortel

Peripatetic philosophy, *PEHR uh puh TEHT ihk,* was established by the Greek philosopher Aristotle. Many scholars believe the word *peripatetic* may be traced to a Greek word meaning *a covered walk.* At the Lyceum, a school Aristotle founded in Athens, students were taught beneath a covered walk called a *peripatos.* Peripatetic philosophy may have received its name from this custom.

Aristotle was a pupil of Plato, who felt that a person could reach the truth only by logic and reason. Plato taught that the world of *appearances* (everyday life) did not accurately represent the real world, which consisted of true ideas. Aristotle believed that reality could not be separated from appearance. He felt that to know reality, a person had to study appearances. Aristotle held that everything except pure form (God) and pure matter was a combination of both form and matter. S. Marc Cohen

See also **Aristotle.**

Periscope, *PEHR uh skohp,* is an optical instrument with which a person can observe objects from a distance or when vision would normally be blocked. In its simplest form, the periscope consists of a long tube with a reflecting mirror or prism at each end. These reflecting surfaces are exactly parallel to one another, and are arranged at an angle of 45 degrees with the axis of the tube. They normally enlarge the image.

Periscopes are important in submarines and tanks, and other weapons. Submarines can remain submerged at *periscope depth*—about 30 feet (9 meters) below the surface—while officers observe objects above the surface with the periscope. Tanks can remain closed and protected against gunfire and chemical weapons while their crews use periscopes. Periscopes enable helicopter gunships to hover behind trees or hills while the crew makes observations and shoots missiles.

Periscopes are also used in laboratories and nuclear reactors. They permit scientists and engineers to make observations without endangering themselves.

Electronic periscopes that use *optical fibers* are being developed. Such fibers can carry images long distances. See **Fiber optics.** Norman Polmar

See **Submarine** (picture: An attack submarine).

Peritonitis, *PEHR uh tuh NY tihs,* is an inflammation of the *peritoneum,* the thin membrane that lines the abdominal cavity. It is an illness that can cause death. The peritoneum may become inflamed if it is attacked by bacteria or irritated by a foreign substance.

Peritonitis may be either *chronic* or *acute. Chronic peritonitis* lasts for a long time. It can cause inflamed tissues to grow together. As a result, the intestines may not work properly. People suffering from tuberculosis sometimes develop chronic peritonitis.

Acute peritonitis occurs suddenly. The inflammation may affect a small part of the peritoneum, or it may involve a large area. It starts with fever, chills, vomiting, and severe abdominal pain. The abdomen becomes rigid and swells. The pulse becomes rapid, and the number of white blood cells increases.

Acute peritonitis is caused by bacteria that escape from such organs of the body as the alimentary canal, fallopian tubes, or pancreas. Bacteria can escape from an organ such as the appendix if the organ is so badly infected that it tears open. This may follow such conditions as gangrene of the intestine, a damaged bowel, or an infected pancreas.

Peritonitis requires prompt medical care. Antibiotics and other drugs are used to treat any infection and control pain. If an organ breaks open, an operation is usually performed as soon as possible to close the opening and drain the infection. Andrew G. Plaut

Periwinkle, a plant. See **Myrtle.**

Periwinkle, *PEHR uh WIHNG kuhl,* is the common nam for a group of marine snails. Periwinkles have a thick, rounded shell that is normally dark in color. They usua

ling to rocks that lie in shallow waters or on seashores. eriwinkles feed on tiny plants and on simple plantlike rganisms called *algae.* One well-known periwinkle is ıe common periwinkle. It grows up to $1\frac{1}{2}$ inches (4 cen- meters) long and lives in northern Europe and the tlantic coast of North America. Many Europeans eat ıis periwinkle. Robert S. Prezant

Scientific classification. Periwinkles belong to the family ttorinidae. The scientific name for the common periwinkle is *ttorina littorea.*

'erjury, *PUR juhr ee,* is a crime in which a person vears or affirms to tell the truth in a court of law or in ı administrative or legislative proceeding, and then de- berately tells a lie. In most states, the lie is perjury only it has a direct bearing on the issue before the court, ibunal, or legislative body. An unintentional misstate- ıent is not considered perjury. A person is guilty of *ıbornation of perjury* when he or she causes another erson to commit perjury. Subornation of perjury is also crime. Perjury is usually considered a felony.See also elony; Trial. Jack M. Kress

erkins, Frances (1880-1965), became the first oman Cabinet member in the United States govern- ıent. She served as secretary of labor under President ranklin D. Roosevelt from 1933 to 1945. While in the abinet, she became chairman of the President's ommittee on Economic Security. This committee's re- ɔrt formed the basis for the Social Security Act, passed 1935.

United Press Int.

Frances Perkins

Fannie Coralie Perkins as born in Boston. She ıanged her given name Frances in about 1905. rkins graduated from ount Holyoke College in 02 and received a mas- r's degree from ɔlumbia University in 10. She soon became a ader in social reform ef- rts in New York, seeking improve working con- tions through legislation ı such issues as safety, aximum hours, and minimum wages. From 1929 to 33, Perkins served as New York's Industrial ımmissioner. In 1946, President Harry S. Truman ap- ɔinted her to the United States Civil Service ımmission. She served on the commission until 1953. rkins wrote *People at Work* (1934) and *The Roosevelt I ew* (1946). Alonzo L. Hamby

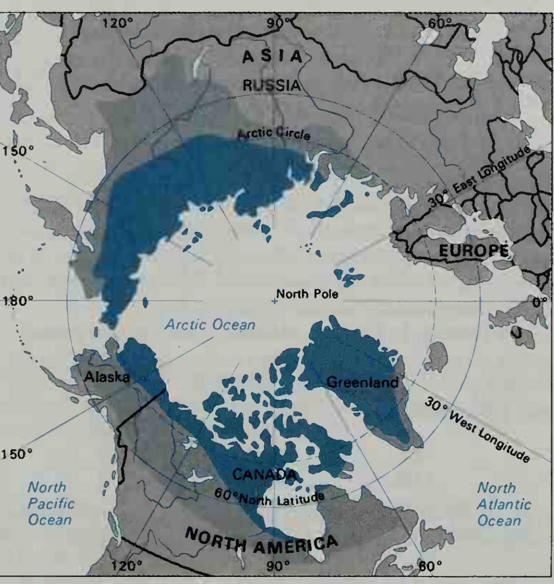
:rlman, Itzhak, *EETS zhahk* (1945-), is a noted aeli violinist. He is known for his rich tone, his techni- mastery, and the joy and warmth he communicates in playing.

Perlman was born in Tel Aviv. In 1958, he was a winner an Israeli talent competition. Perlman and other win- rs traveled to the United States to tour and appear on evision. He remained after the tour and continued his ısical training at the Juilliard School in New York City. 1963, he made his professional debut at Carnegie Hall New York City. In 1964, he won the Leventritt Compe- ɔn, a contest among young musicians. This victory led concert performances all over the world.

Perlman contracted polio at age 4, and his legs be- came permanently paralyzed. He walks with crutches and performs seated. Perlman actively promotes laws to ease the access of disabled people to buildings and transportation. Stephen Clapp

Permafrost is ground that remains frozen for two or more years. Such ground may consist of rock, sand, or soil. Usually, ice surrounds this material, binding it into a solid mass. *Dry permafrost* occurs in rock and gravel where there is little ice. Permafrost may be *continuous* or *discontinuous.* Continuous permafrost occurs where the mean annual air temperature remains below 18°F (- 8°C). Discontinuous permafrost has areas of unfrozen land within larger, permanently frozen areas.

Permafrost in the Northern Hemisphere



WORLD BOOK map

Permafrost underlies about a fourth of the world's land. In Canada, it underlies about half the land. In Canada and Russia above the Arctic Circle, the ground is frozen to depths up to 5,000 feet (1,500 meters).

In summer, soils thaw in an *active layer* above the per- mafrost. The depth of this layer ranges from 8 to 25 inch- es (20 to 64 centimeters) in *peat* (partly decayed plant matter) and from 20 to 110 inches (50 to 280 centimeters) in sand and gravel. Heat from buildings, roads, railways, pipelines, and other structures may thaw massive amounts of ice in permafrost, often causing damage to these structures. Lawrence C. Bliss

Permalloy, *PUR muh loy,* is a nickel-iron alloy that is easy to magnetize. It can be magnetized by wrapping an insulated wire around it and sending an electric current through the wire. Permalloy loses its magnetism when the current is turned off. When a weak alternating cur- rent is sent through a coil wound around a Permalloy bar, it produces a strong magnetic field in the material. For this reason, Permalloy is an ideal material for use as

the core of the low-power inductors and transformers used in communication engineering. The term *Permalloy* comes from the two words *permanent* and *alloy.* Permalloy was developed in 1916 by G. W. Elmen, an engineer for the Western Electric Company. Today, scientists are developing new alloys that have better magnetic properties than Permalloy. I. Melvin Bernstein

Permian Period. See Earth (table: Outline).

Permutations and combinations are names that mathematicians use for certain groups of objects or symbols. *Permutations* are *ordered arrangements* of a set of objects. For example, ABC, ACB, and BAC are three permutations of the set of symbols A, B, and C. *Combinations* are those groups that include the same objects *regardless of the order in which they are arranged.* The sets ABC, ACB, and BAC are all examples of the same combination. Sets such as ABC, ABD, and ACD are examples of different combinations.

The branch of mathematics that includes permutations and combinations is called *combinatorics.* Combinatorics has many uses, including the routing of telephone calls through cables and the scheduling of production in factories. It has become an area of active research as computers have grown in importance.

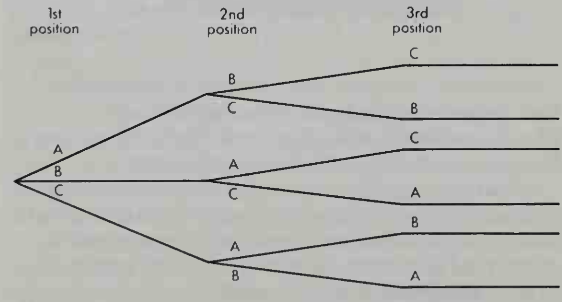
Counting permutations

The question, "How many sets of letters can be formed from the three letters A, B, and C?" is the same as the question, "How many permutations are there of 3 objects taken 3 at a time?" You can find the answer (1) by making a list of all the possibilities, (2) by reasoning, and (3) by using mathematical formulas.

By listing. To find the answer by listing, you merely write down all the possibilities and count them. The list below shows there are 6 possibilities. Therefore there are 6 *permutations* of 3 objects taken 3 at a time.

ABC	**BAC**	**CAB**
ACB	**BCA**	**CBA**

You could also list the possibilities in the form of a tree diagram that shows the choices for each position:



The diagram again shows that you can form 6 sets.

By reasoning. You could also find the number of permutations by reasoning. For the first position, you have 3 possible choices, A or B or C. With each of these choices, you have only 2 possible choices left for the second position, and $3 \times 2 = 6$. With each of these 6, you have 1 possible choice for the third position, and $6 \times 1 = 6$. Therefore, the number of possible sets of letters is $3 \times 2 \times 1 = 6$.

Using reason is better than just listing the permutations because reasoning accounts for every possibility. In listing, you might forget to include some possibilitie especially if you had a large number of objects.

Suppose, for example, that you had 26 letters instead of only the letters A, B, and C, and that you were asked to find the total number of sets of *3* letters that could be formed. Listing all the possibilities would be difficult and tedious. But finding the answer by reasoning woul be easy. With every one of the 26 possible choices for the first position, there would be 25 choices for the sec ond position. This makes a total of 650 possibilities ($26 \times 25 = 650$). With each of these 650 choices, there would be 24 letters remaining as possible choices for the third position, making a total of 15,600 possible con binations ($650 \times 24 = 15{,}600$). The total number of permutations is therefore $26 \times 25 \times 24 = 15{,}600$.

The above example illustrates the *multiplication prin ciple* for permutations: *If the first position can be filled in* n *ways, and the second can be filled in* n-1 *ways, an the third in* n-2 *ways, then the total number of permuta tions in the three positions is* n × (n-1) × (n-2).

Suppose you had only A's, B's, and C's, but at least *3* of each. How many sets of 3 initials could you form? (The sets would include AAA, AAB, ABB, and so on.) In this example, each position could be filled in 3 differen ways, and so you could calculate the answer: $3 \times 3 \times$: $= 27$ sets. With 26 letters and at least 3 of each, you could form $26 \times 26 \times 26 = 17{,}576$ sets.

By using symbols and formulas. In mathematical terms, the number of permutations of n things taken r a time is represented by the symbol P^n_r (sometimes wri ten ${}_nP_r$). Using this symbol, you can express the answe to permutation problems as follows:

3 things (such as A, B, and C) taken 3 at a time

$$P^3_3 = 3 \times 2 \times 1 = 6$$

26 things taken 3 at a time

$$P^{26}_3 = 26 \times 25 \times 24 = 15{,}600$$

n things taken r at a time

$$P^n_r = n(n-1)(n-2)\ldots[n-(r-1)]$$

The last expression is the general formula. The brac eted quantity, $[n-(r-1)]$, means n minus the quantit $(r-1)$. Algebraically, this quantity is the same as $(n -$ $+ 1)$. This quantity tells you at what point to stop writir successive multipliers in the formula. For example, if n 26 and r is 3, then $(n - r + 1) = 26 - 3 + 1 = 24$ and so the multipliers for P^{26}_3 are $26 \times 25 \times 24$.

Solving combination problems

If you had 4 books, how many sets of 3 books could you form? This question is the same as the question, "How many *combinations* are there of 4 things taken 3 a time?" Suppose, for example, that the 4 books were written respectively by Adams, Beery, Cole, and Doe. I you chose books by Adams, Beery, and Cole, your rea ing material would be the same regardless of the ord in which you read the books. Thus, there is only 1 *con bination* of these 3 books taken 3 at a time. How many other 3-book combinations could you make from the books? As in the permutation problem above, you ca find the answer (1) by listing the possibilities, (2) by re soning, and (3) by using mathematical formulas.

By listing. For simplicity, represent the 4 books by

e letters A, B, C, and D. Write down several groups of ese 4 letters, and then cross out one letter at a time, al-ays leaving a group of 3. You would cross out a differ-it letter each time so that the remaining group would ways be a different combination.

ABC~~D~~ ⟶ ABC
AB~~C~~D ⟶ ABD
A~~B~~CD ⟶ ACD
~~A~~BCD ⟶ BCD

ie list shows that there are 4 possible combinations.

By reasoning. A knowledge of permutations enables ›u to arrive at the answer in the following way. You can :lect any 3 of the books in 6 different orders, for exam-e, ABC, ACB, BAC, BCA, CAB, CBA. But these 6 *permu-tions* represent only a single *combination.* You can onclude that there are 6 permutations for *each* differ-it combination of 3 books. Therefore, the total number permutations must be equal to 6 times the number of ›ssible combinations. Likewise, the number of possi-e combinations must be equal to the total number of ermutations divided by 6. The total number of permu-tions of 4 books taken 3 at a time is

$$P_3^4 = 4 \times 3 \times 2 = 24$$

The number of permutations for each combination of books is

$$P_3^3 = 3 \times 2 \times 1 = 6$$

Therefore, the number of possible combinations is $4 \div 6 = 4$.

Suppose you want to count how many combinations 3 different letters could be in a spoonful of alphabet ›up. In the section of this article on counting permuta-›ns, we calculated that the total number of permuta-›ns of 26 letters taken 3 at a time is $26 \times 25 \times 24 =$;,600. We also calculated that the number of permuta-›ns for each combination of 3 letters is $3 \times 2 \times 1 = 6$. ierefore, the number of possible combinations in our ›oonful of soup is $15{,}600 \div 6 = 2{,}600$.

By using symbols and formulas. The number of ›mbinations of n objects taken r at a time is repre-›nted by the symbol C_r^n (sometimes written $\binom{n}{r}$ or ${}_nC_r$). ı the book example, the number of possible combina-›ns can be expressed and calculated as follows:

$$C_3^4 = \frac{P_3^4}{P_3^3} = \frac{4 \times 3 \times 2}{3 \times 2 \times 1} = \frac{24}{6} = 4$$

he general formula for combinations is

$$C_r^n = \frac{P_r^n}{P_r^r} = \frac{n(n-1)(n-2)\ldots(n-r+1)}{r(r-1)(r-2)\ldots 3 \times 2 \times 1}$$

›r example, if $n=6$ and $r=4$,

$$C_4^6 = \frac{6 \times 5 \times 4 \times 3}{4 \times 3 \times 2 \times 1} = 15$$

Mathematicians simplify the formula for C_r^n by using *ctorial notation* to represent the product of a positive hole number with all the positive whole numbers less ıan itself. *Factorial 3* means $3 \times 2 \times 1$, and it is written . Likewise, 4! means $4 \times 3 \times 2 \times 1$. Permutation for-ıulas can therefore be simplified as follows:

$$P_3^3 = 3! \qquad P_4^4 = 4! \qquad P_r^r = r!$$

The simplified combination formula is

$$C_r^n = \frac{n(n-1)(n-2)\ldots(n-r+1)}{r!}$$

Mathematicians simplify the above formula even more and write it as follows:

$$C_r^n = \frac{n!}{r!(n-r)!}$$

The last two formulas are the same because

$$\frac{n!}{r!(n-r)!} =$$

$$\frac{n(n-1)(n-2)\ldots(n-r+1)(n-r)(n-r-1)}{r!(n-r)(n-r-1)} \cdot \frac{(n-r-2)\ldots 3 \times 2 \times 1}{(n-r-2)\ldots 3 \times 2 \times 1}$$

All factors in this expression can be divided out except for $n(n-1)(n-2)\ldots(n-r+1)$ in the numerator and $r!$ in the denominator. These are the same factors that appear in the original combination formula.

With the two forms of the combination formula, you can calculate the number of possible combinations in two ways. For example, if you had 5 books from which to choose a set of 3, you could find the number of combinations as follows:

$$C_3^5 = \frac{5 \times 4 \times 3}{3 \times 2 \times 1} = 10$$

$$C_3^5 = \frac{5 \times 4 \times 3 \times 2 \times 1}{(3 \times 2 \times 1)(2 \times 1)} = 10$$

If you divide out factors in the numerator and denominator of the above expressions, you will see that they are identical. See also **Factor.**

History

The real development of mathematical thought about permutations began in the 1600's with the development of the theory of probability. About this time, the French mathematician Blaise Pascal discovered an interesting device for computing combinations. The device, called the *Pascal triangle,* is shown in the illustration. Pascal constructed the triangle so that each number was the sum of the two numbers above it. The numbers, called elements, are arranged in *rows.* Each element has a *place* in a row determined by counting from left to right. Thus, 20 appears in the 4th place of the 7th row of the triangle.

Pascal found that the element in the $(r+1)$th place of the $(n+1)$th row is the same as the number of combinations of n things taken r at a time (C_r^n). If n is 6 and r is 2, the number of combinations is given in the 7th row, the 3rd place (15, as circled). But 15 also appears in the 5th place of the 7th row (dashed circle). Because the triangle is sym-

1
1 1
1 2 1
1 3 3 1
1 4 6 4 1
1 5 10 10 5 1
1 6 15 20 15 6 1

metrical, the element that is in the $(r+1)$th place of the $(n+1)$th row is always the same as the element in the $(n-r+1)$th place of that row. Therefore, $C^n_r = C^n_{n-r}$. For example, if n is 6 and r is 2, the same number of combinations is possible if the objects are taken 2 or 4 at a time. Thomas J. Brieske

Pernicious anemia. See Anemia.

Perón, *pay ROHN,* **Eva Duarte de,** *AY vah DWAHR tay day* (1919-1952), was the second wife of President Juan Perón of Argentina. Eva, also called Evita, helped Perón rise to power and became one of the most famous women of her day.

Eva Perón was born Maria Eva Duarte in Los Toldos near Buenos Aires. Her family was poor, and she went to Buenos Aires at the age of 15 to become an actress. She met Perón in 1944 when she was a successful radio actress, and married him in 1945. In 1946, he became president of Argentina. Eva began to serve as his contact with the country's labor unions. In 1948, she established a women's branch of Perón's political party.


Wide World
Eva Perón

In 1951, Eva tried to join her husband in the government by running for vice president. But leading Argentine military officers feared that in time she might succeed to the presidency, and they blocked her candidacy. The officers opposed her mainly because they could not accept the idea of a woman becoming the nation's president and top military commander. Eva died of cancer in 1952. Marysa Navarro

See also **Perón, Juan Domingo.**

Perón, *pay ROHN,* **Juan Domingo,** *hwahn doh MEENG goh* (1895-1974), was president of Argentina from 1946 to 1955, and again in 1973 and 1974. He ruled as a military dictator but was idolized by Argentina's workers and was probably the most powerful leader in Argentine history.

Perón was born in Lobos, Argentina. He first shared control of the government after a revolution in June 1943. He held three cabinet posts in the government of President Pedro Ramírez. Perón's reform programs as secretary of labor and social welfare won him the support of labor. He also gained strength from the backing of the army. However, many military officers distrusted Perón. In October 1945, they forced him to resign and had him arrested. Organized labor held mass protest demonstrations, and Perón was soon released.


Larson, Black Star
Juan Perón

Perón was elected president of Argentina in 1946. His second wife, Eva Duarte de Perón, helped him rise to power. She died in 1952. See **Perón, Eva Duarte de.**

Perón aimed to make Argentina the leading political financial, and military power of Latin America. He was one of the first leaders to outline the "third position," a policy of refusing to support either the Communist or the non-Communist *bloc* (group of nations).

Perón used press censorship and other violations of civil rights to control his opposition. In 1955, the Roma Catholic Church broke with Perón after he had challenged its authority and had legalized divorce and pro titution. In September 1955, the army and navy revolte and forced Perón to resign. Perón moved to Spain, but his followers, called *Peronistas,* remained active.

The Peronistas gained strength during the late 1960 and early 1970's, a period of economic problems in Ar gentina. In 1973, Perón returned to Argentina and was elected president. His third wife, Isabel Martinez de Perón, was elected vice president. Perón died in 1974, and his wife succeeded him. Military leaders deposed her in 1976. See **Argentina** (Military dictatorships; Nev political problems; picture). Paul B. Goodwin, Jr.

Additional resources

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Perot, *puh ROH,* **Ross** (1930-), is an American businessman who became an independent candidate for president of the United States in 1992 and 1996. A billionaire, Perot gained widespread support even though he had little political experience.

Many people supported Perot's candidacies for pre dent because they considered him a political "outside with no commitments to powerful interest groups. Some voters thought Perot's business background would make him an effective president.

In February 1992, Perot had promised to run for pre dent if his name were placed on ballots in all 50 states before the November 1992 election. But in July, he announced that he would not seek the presidency, statir he did not believe he could win enough votes to be elected. Nevertheless, campaign workers later succeeded in putting his name on all the states' ballots. Then, in October, Perot announced his candidacy for the presidency. Perot chose as his running mate Jame B. Stockdale, a retired United States Navy vice admira Perot received about a fifth of the popular vote in the election, which was won by the Democratic candidat Governor Bill Clinton of Arkansas.

In 1996, Perot became the presidential nominee of e Reform Party, which he had founded. He chose economist Pat Choate as his running mate. Perot finished third in the election, which was won by President Clinton, the Democratic candidate. Senator Robert J. Dole of Kansas, who was the Republican nominee, was the runner-up.


© Brad Markel, Gamma-Li on
Ross Perot

Perot was born in Texarkana, Texas. He was named Henry Ray Perot at birth,

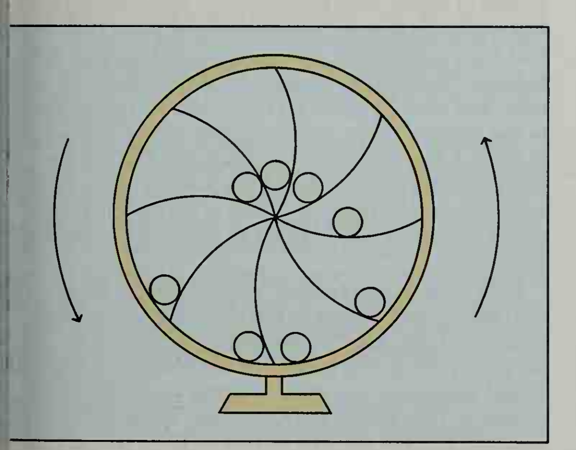
ut he and his parents changed his name to Henry Ross erot when he was 12 years old. In 1953, Perot graduted from the U.S. Naval Academy. He served in the U.S. lavy from 1953 until 1957.

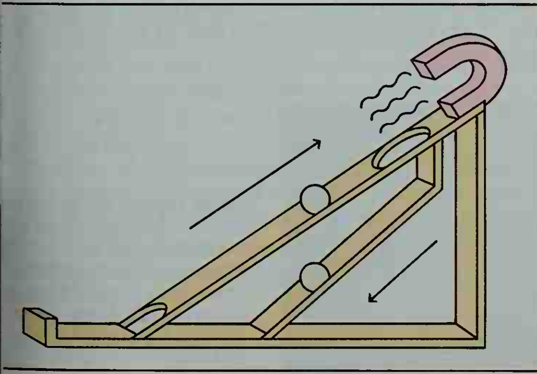
Perot's career in business began in 1957, when he beame a computer salesman for International Business Aachines Corporation (IBM). He left IBM in 1962 and ounded Electronic Data Systems (EDS), a company that rovided computer services. EDS made huge profits, nd Perot became a billionaire.

In 1984, the General Motors Corporation bought EDS om Perot, and he became a member of General Mobrs' board of directors. Perot left General Motors in 986. He founded another computer services company, erot Systems, in 1988. Henry K. Tatum

'erpetual motion machine is a hypothetical deice that can continuously produce work with no energy nput, continuously convert energy completely into vork, or continuously produce more energy than it conumes. No one has ever succeeded in building a perpetal motion machine, and almost all scientists and engieers believe no one ever will.

For a machine to achieve perpetual motion, it would ave to violate one or both of two *laws of thermodynamics.* These laws summarize how machines work. The first law states that energy cannot be created or destroyed. Energy may change form—for example, from internal energy to mechanical motion—but the total energy of any *system* remains the same. A system may be anything from a simple object to a complex machine. The second law says that heat, by itself, can flow only from a hot object to a colder object. See **Thermodynamics.**





WORLD BOOK illustrations by Zorica Dabich

'erpetual motion machines are supposed to run forever, but o one has succeeded in inventing such a device. In the overbalnced wheel, *top,* each descending ball is farther from the ceni and exerts more force than each ascending ball. But because iere are more ascending balls, the wheel does not turn. The nagnetic machine, *bottom,* also does not work. Any magnet that an pull a ball up the ramp will not let it go back down.

Inventors have proposed at least two kinds of perpetual motion machines. The first kind would run forever with no energy input. The second kind would continuously convert energy completely into work. A machine that would continuously yield more energy than it consumes is considered by some experts to be a third type of perpetual motion machine. Other experts class this device with the first kind of perpetual motion machine.

The first kind of perpetual motion machine violates the first law of thermodynamics. This machine will not work, because resistance opposes the moving parts of all machines. To keep running, the machine must use energy to overcome this resistance. Without energy input, therefore, the machine soon stops.

The second type of perpetual motion machine violates the second law. This type of machine traditionally does work by exploiting the natural flow of heat from a hot region to a cooler region. But once the flow of heat has warmed the cool region to the same temperature as the hot region, the machine stops. Some inventors have proposed machines that would continuously produce work by converting all the energy of the randomly moving molecules in the sea or atmosphere. However, no machine has been able to accomplish this, either.

A machine that would continuously produce more energy than it consumed also violates the first law of thermodynamics. This machine would have to create energy.

Some people have considered artificial satellites as possible sources of perpetual motion. But atmospheric friction limits the lifetimes of artificial satellites that orbit relatively close to the earth. Scientists expect that even satellites that orbit the sun may eventually be pulled into it. Nuclear energy has also been considered a possible source of perpetual motion. Uranium and other nuclear fuels do contain tremendous amounts of energy for their size. But after this energy is used up, the remaining matter must be replaced with fresh fuel. See **Nuclear energy.** Robert F. Boehm

See also **Motion.**

Perrault, *peh ROH,* **Charles** (1628-1703), a French writer, is best known for a book of fairy tales he collected, *Tales of Mother Goose.* The collection, published under his son's name in 1697, includes "Sleeping Beauty," "Little Red Riding Hood," "Bluebeard," "Puss in Boots," and "Cinderella." See **Mother Goose.**

Perrault was born in Paris. He became a high-ranking civil servant and a member of the French Academy under King Louis XIV. His older brother was the famous architect and scientist Claude Perrault. Charles was known for his progressive, evolutionary view of history. He helped start a famous literary battle called "The Quarrel of the Ancients and the Moderns." In *The Century of Louis the Great* (1687) and *Parallels Between the Ancients and the Moderns* (1688), he argued that the cul-

ture of his own time was superior to the culture of classical Greece and Rome. He felt that the "Moderns" would win the battle through science, the rational philosophy of René Descartes, and progress in knowledge, culture, and literature. Robert B. Griffin

Perry, Matthew Calbraith (1794-1858), was a famous United States naval officer, best known for opening Japan to Western trade and diplomacy. Japan had virtually isolated itself from Western countries since the early 1600's. It had resisted, sometimes by force, attempts by Americans and Europeans to establish business and diplomatic ties. In 1854, Perry negotiated a treaty between Japan and the United States. This was Japan's first modern treaty with a Western nation and marked the beginning of Japan's development into a major world power.

On July 8, 1853, Perry sailed into a hostile Japan with four warships. He headed a United States expedition to begin diplomatic and trade relations with Japan and to ensure the safety of Americans shipwrecked in the country.

Perry impressed the Japanese with a show of dignified strength. He presented Japanese officials with a letter from United States President Millard Fillmore to the Japanese emperor proposing peace and friendship. On March 31, 1854, Japan entered into a treaty of peace, friendship, and trade with the United States. Perry wrote a record of the expedition, *Narrative of the Expedition of an American Squadron to the China Seas and Japan.* The record was published in 1856.

Perry was born on April 10, 1794, in Newport, Rhode Island. In 1809, Perry entered the United States Navy as a midshipman. Perry first served on the *Revenge.* This ship was commanded by Oliver Hazard Perry, Matthew's brother. Matthew fought and was wounded in the War of 1812. Perry served as executive officer on the *Cyane.* In 1820, the *Cyane* carried freed slaves to Africa in order to help establish a colony. The colony later became Liberia.

Perry became a captain in 1837 and later took command of the *Fulton II,* one of the first naval steamships. He became deeply involved in the development of the United States Naval Academy at Annapolis, Maryland. In 1839 and 1840, he directed the first school of naval gunnery, on board the *Fulton II.*

In 1843, Perry commanded the African Squadron. This squadron was set up to protect the expanding American settlements in Liberia and to help suppress the slave trade. In the Mexican War (1846-1848), Perry commanded the squadron that helped General Winfield Scott seize Veracruz, Mexico. Perry died on March 4, 1858.

Kinley J. Brauer

See also **Japan** (Renewed relations with the West; picture).

Perry, Oliver Hazard (1785-1819), was a United States naval officer who became noted for his heroism during the War of 1812. At the outbreak of the war, Perry was a naval lieutenant but had no sea command. After being promoted to master commandant, he offered his services on the Great Lakes, and received command of the Lake Erie naval force.

Except for a brief period when he fought on Lake Ontario and helped capture Fort George in Canada, Perry spent the spring and summer of 1813 in Erie, Pennsylvania, outfitting all of his vessels for battle. He left Erie in August.

Perry made his headquarters at Put-in-Bay, off the Ohio shore, and on Sept. 10, 1813, sailed from there to fight the British. His fleet included nine small ships, the largest of which were the *Lawrence,* commanded by Perry, and the *Niagara,* commanded by Jesse Duncan Elliott. During the battle, the *Niagara* took little part in the fighting. The *Lawrence* suffered a large number of casualties and after $2\frac{1}{2}$ hours was disabled. Perry then rowed to the *Niagara.* Under Perry's command, the *Niagara* kept the British from boarding the *Lawrence.* Two British ships became entangled, and the *Niagara* raked them with broadsides. The British fleet of six vessels surrendered soon after Perry had taken command of the *Niagara.*

Perry then sent to General William Henry Harrison, the military commander in the West, the famous message, "We have met the enemy, and they are ours." For his victory, Perry was promoted to captain and received a gold medal and monetary rewards. The victory gave control of Lake Erie to the Americans. General Harrison was able to cross the lake and take a large part of Upper Canada. Perry helped transport the troops. He later took part in the battle around Detroit and on the Thames River in Canada.

U.S. Navy



Oliver Hazard Perry and his fleet of nine ships defeated the British in the Battle of Lake Erie during the War of 1812. This picture shows Perry rowing to the ship *Niagara* after his ship, the *Lawrence,* was disabled.

Perry was born in South Kingston, Rhode Island. At ne age of 14, he became a midshipman and served in he West Indies under his father, who was a naval offi- er. During the war with Tripoli (1801-1805), he served in ships in the Mediterranean Sea. In 1807, as a lieu- enant, Perry directed the construction of gunboats at Newport, Rhode Island. He next took command of the *Revenge,* which ran aground in a fog in 1811 and was ost. An inquiry cleared Perry of any blame for this loss because a pilot had been in charge of the ship at the ime it ran aground. In 1819, Perry took a small fleet to Venezuela on a diplomatic mission for the government. While sailing homeward along the Orinoco River after his mission, he contracted yellow fever and died.

Michael J. Crawford

See also **Pennsylvania** (Visitor's guide; picture).

Perry, William James (1927-), served as United States secretary of defense from 1994 to 1997, under President Bill Clinton. Perry, a mathematician, had spent much of his career working on defense technology.

Perry was born in Vandergrift, Pennsylvania. In 1946 and 1947, he was a surveyor in the United States Army Corps of Engineers. Perry received bachelor's and mas- er's degrees in mathematics from Stanford University in 1949 and 1950, respectively. He earned a Ph.D. in math rom Pennsylvania State University in 1957. From the 1950's to the 1970's, Perry worked for a number of mili- ary electronics firms. In 1964, Perry became a co- ounder of ESL, Inc., which developed electronic detec- ion systems.

Perry became a consultant to the Department of De- ense in 1967. As the department's undersecretary for re- search and engineering, from 1977 to 1981, he urged the armed forces to adopt advanced technology, including "stealth" aircraft, which are hard to detect by radar. From 1981 to 1993, Perry worked as an investment banker. He served as co-director of Stanford's Center for Interna- tional Security and Arms Control from 1989 to 1993, when he became deputy secretary of defense.

W. Patrick Towell

Persephone, *puhr SEHF uh nee,* was a beautiful god- dess in Greek and Roman mythology. The Greeks also called her *Kore.* The Romans called her *Proserpina.* Per- sephone was the daughter of Demeter (Ceres in Roman mythology), the goddess of agriculture and fertility. Per- sephone's father was Zeus (Jupiter), the king of the gods. An important myth describes Demeter's search for Per- sephone after the girl was kidnapped by Hades (Pluto), god of the dead.

One day, while Persephone was picking flowers in a meadow, the earth opened up. Hades seized Perseph- one and carried her to his underworld kingdom to be- come his wife. Demeter was heartbroken at the loss of her daughter. She wandered the world looking for Persephone.

Demeter became angry with the gods for allowing Persephone to be carried off. In revenge, Demeter re- fused to let crops grow. To return fertility to the earth, Zeus ordered Hades to return Persephone to her mother. But while in the underworld, Persephone had eaten seeds of the pomegranate, a fruit that symbolized marriage. By eating the seeds, she entered into a mar- riage with Hades that could not be ended.

Zeus arranged a compromise between Demeter and Hades. Persephone would spend two-thirds of each year with her mother and the remaining third with Hades. While Persephone lived with Hades, the earth became dry and barren, reflecting Demeter's unhappiness. But while Demeter and Persephone lived together, crops flourished. The myth of Persephone was used to help explain the cycle of fertility in nature. Justin M. Glenn

See also **Adonis; Demeter.**

Persepolis, *puhr SEHP uh lihs,* was a capital of ancient Persia. King Darius I of Persia built Persepolis about 500 B.C. in a mountain region of what is now southwest Iran. Darius and his successors constructed large stone and mud-brick palaces in the capital, which became the roy- al ceremonial center for the religious holiday of the New Year. Every year at this festival, the king would re- new his divine right as king, and representatives of all the peoples within the Persian Empire would bring him gifts. In 330 B.C., Alexander the Great seized Persepolis.

Archaeologists have uncovered a large number of the ruins of Persepolis. Some of the ruins have been re- stored. Visitors may see a representation of the proces- sion of New Year's gift givers carved in stone on two grand staircases leading to the king's Audience Hall.

Jack Martin Balcer

See also **Persia, Ancient** (picture).

Perseus, *PUR see uhs,* in Greek mythology, was the son of the god Zeus and the mortal Danaë. King Acri- sius, Danaë's father, learned from an oracle that his own grandson would someday kill him. In fear, he set the in- fant Perseus and Danaë adrift in a chest. Dictys, a fisher- man, rescued them. Perseus grew to manhood in Dic- tys's home on the island of Seriphus.

King Polydectes, Dictys's brother, tried to force Danaë to marry him. To prevent the marriage, Perseus agreed to slay Medusa, a snake-haired monster called a Gorgon whose horrible face turned all who looked at her to stone. With the help of the goddess Athena, Perseus be- headed Medusa while gazing at her reflection in his shield (see **Gorgons; Medusa**).

While returning home, Perseus rescued the beautiful maiden Andromeda from a giant sea monster and mar- ried her. In Seriphus, he turned Polydectes to stone with the head of the Medusa. Perseus later accidentally killed his grandfather with a discus, fulfilling the prediction of the oracle. Nancy Felson

Perseus, *PUR see uhs,* is a constellation of the north- ern sky. It lies between the constellations of Auriga and Cassiopeia. Mirfak, the brightest star in Perseus, is larger than the sun. Perseus contains the *binary star* Algol. The pair of stars called Algol periodically eclipse each other, so that Algol appears alternately fainter and brighter (see **Algol**). In Greek mythology, Perseus won this place among the stars for cutting off the head of the monster Medusa. See also **Constellation.** Sumner Starrfield

Pershing, *PUR shihng,* **John Joseph** (1860-1948), commanded the American Expeditionary Forces (A.E.F.) in Europe in World War I (1914-1918). The A.E.F. was the first United States army ever sent to Europe. Pershing trained and led in battle an army that grew within 18 months from a small group of regulars to almost 2 mil- lion men. After the war, he received the highest rank ever given an American Army officer, General of the Armies of the United States. But Congress granted the same title to George Washington in 1976, so that no



Brown Bros.

General John J. Pershing led his troops down New York's Fifth Avenue after World War I ended in 1918.

other general, past or present, would outrank him.

Teacher-soldier. Pershing was born near Laclede, Missouri. He began to teach in a local black school at age 17.

Pershing graduated from the U.S. Military Academy in 1886 and began active service by fighting against the Apache. While serving as military instructor at the University of Nebraska, Pershing earned a law degree.

Pershing was teaching tactics at the U.S. Military Academy when the Spanish-American War began in 1898. He fought with distinction as a first lieutenant with the 10th Cavalry in the Santiago campaign.

Promotion. Pershing served in the Philippines from 1899 to 1903 and directed the Mindanao Island campaign against the rebellious Moros tribe. He was still a first lieutenant at age 40 and considered resigning from the Army because of slow promotion. But he became a captain in the Philippines. His work in subduing the Moros, who had never been conquered, won the admiration of President Theodore Roosevelt.

Pershing became military attaché to the U.S. Embassy in Japan after the outbreak of the Russo-Japanese War in 1904. He went with Japanese General Tamemoto Kuroki to Manchuria, where as military observer he studied modern warfare on a large scale. He returned to the Philippines after the war. In 1906, President Roosevelt raised Pershing's rank from captain to brigadier general.

Mexican campaign. In 1916, Pershing took command of the army that entered Mexico in pursuit of Pancho Villa and his rebels. Villa's troops had raided and burned the border town of Columbus, New Mexico. Although Pershing did not capture Villa, the long pursuit made "Black Jack" Pershing (so called because he had once commanded an all-black troop) a public figure in the United States. When the United States entered World War I in 1917, he was chosen to command the A.E.F.

World War I. Upon arriving in France, Pershing laid a wreath on the tomb of the Marquis de Lafayette. One of his staff officers, Colonel Charles E. Stanton, gave a speech on Pershing's behalf. In the speech, Stanton said "Lafayette, we are here." This symbolized the repayment of aid that Lafayette and other French people had given America during the Revolutionary War.

Pershing's greatest work as commander of the American Expeditionary Forces was to preserve the unity of the American army in combat and maintain the spirit of the offensive. The Allied generals wanted to use the American troops to fill the ranks of their battered armies, but Pershing insisted that, except in certain cases, the American army should fight independently. He believed that the arrival of a large, fresh American army at the front would hurt German morale. Also, the Americans had been trained for fast, driving warfare, which Pershing believed was needed to win. Pershing opposed the slow trench warfare of the Allied armies. His theory of offensive warfare, though it cost many American lives, succeeded against the German army.

Later career. Pershing served as chief of staff of the U.S. Army from 1921 to 1924. After his retirement, he served as chairman of the American Battle Monuments Commission and in several honorary diplomatic assignments. During World War II (1939-1945), he consulted with Army Chief of Staff George C. Marshall, but took no other active part in the war. Pershing was buried in Arlington National Cemetery. Christopher R. Gabel

See also **World War I** (American troops in Europe).

Additional resources

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Vandiver, Frank E. *Black Jack: The Life and Times of John J. Pershing.* 2 vols. Tex. A & M Univ. Pr., 1977.

Persia. See **Iran; Persia, Ancient.**

Persia, Ancient, was a land that included parts of what are now Iran and Afghanistan. Under Cyrus the Great, Darius I, Xerxes, and other leaders it became the home of a great civilization, and the center of a vast empire. The name *Persia* came from *Persis,* the Greek name for the region. The Persians themselves called the region the *land of the Aryans,* from which the name *Iran* comes. The Persians called their language *Aryan.*

The early Persians were nomads who came to the area around 1000 B.C. from the land that surrounds the northern part of the Caspian Sea. They were good organizers and administrators, and the empire that their descendants created lasted over 200 years. They made important contributions in government, law, and religion. The Persians developed an efficient "pony express" relay system of mail delivery, built an irrigation system, and tried to standardize weights and measures. For a quotation about their postal system, see **Postal services** (Ancient times).

The Persians treated their subjects better than earlier rulers had, and they probably influenced the actions and policies of later governments. Alexander the Great built on Persian accomplishments to unify his empire. So did the Arabs in building their civilization.

In the 500's B.C., Persia became the center of the vast Achaemenid Empire. The Achaemenid Empire extended from North Africa and southeastern Europe in the west to India in the east, and it stretched from the Gulf of Oman in the south to the Caucasus Mountains and the Syr Darya River in the north. The Persians governed an



Robert Harding Picture Library

Ruins of Persepolis, ancient Persia's greatest city, lie in southwestern Iran. Darius I built the center about 518 B.C. Parts of Darius' audience hall, *left,* and palace are still standing.

·ea almost as large as the continental United States. ersians invaded Greece in the early 400's B.C. But the reeks drove them from Europe, ending the empire's xpansion. Alexander the Great conquered the empire 331 B.C. Later, Parthians and Sassanids controlled Persia before Arabs conquered it in A.D. 641.

Way of life

The people. Persians dressed in long robes, later illed *caftans,* and wore jewelry and false hair. Most of e common people lived in mud huts, much like the its many of the country people of Iran live in today. obles and kings built large stone houses and palaces. ie ruins of some of these still stand.

The Persians adopted many of the customs of the amites, the people they had conquered. But they kept any traditions of the *nomadic* (wandering) peoples. For ample, they taught their sons to ride horses, shoot ows, and speak the truth. The Persians considered it a sgrace to lie or to be in debt.

Early Persian families formed into clans, and clans to tribes. But as the empire grew, social units larger an the family began to disappear. Persian men could ive several wives. A king could select his wives only om the six highest families. Rulers had large *harems,* here all the women in the family lived.

Language and literature. The people of ancient Persia spoke Old Persian, a language of the Indo-European mily related to the Sanskrit language of India and to odern Persian. The Persians developed a cuneiform stem of writing (see **Cuneiform**). But the cuneiform stem was used only for royal inscriptions, because w people could read it. The Persians used Aramaic, a mitic language related to Hebrew, as a written language. Aramaic was widely used in Syria, Palestine, and esopotamia then, and the Persians extended its use to dia, central Asia, and Asia Minor (now Turkey). Local languages were used in various parts of Persia.

Little is known of the literature of ancient Persia. But stories of ancient heroes still survive, probably passed along by minstrels and folk tales.

Religion. The Persians believed in gods of nature, such as the sun and sky. The people believed the gods had social powers. Mithra, the god of light, for example, controlled contracts. The Persians had no temples. They prayed and offered sacrifices on mountains.

Zoroaster (or Zarathustra), a prophet who lived sometime between 1400 and 1000 B.C., reformed the ancient religion. He preached a faith based on good thoughts, words, and deeds, emphasizing a supreme god called Ahura Mazda, "the wise spirit." Zoroaster's followers, called *Zoroastrians,* gradually spread his religion throughout Persia. The teachings of Zoroaster are found in the *Gathas,* part of a holy book known as the *Avesta.*

Art and architecture in ancient Persia was a unique mixture of Greek, Egyptian, Babylonian, and other cultures. Remains of huge royal palaces have been found that stood at Pasargadae, Persepolis, and Susa, in what is now Iran. Goblets, plates, and other objects made of gold during the Persian Empire have been found. After Alexander the Great conquered Persia, silver became popular, and many silver art objects have been found. Many museums exhibit ancient Persian textiles, rugs, and pottery.

Economy. Early Persians were farmers. They raised grain and livestock. Deserts covered much of the highland region, and the peasants developed irrigation to grow wheat, barley, oats, and vegetables. They used underground tunnels to avoid evaporation by the hot sun, and brought water as much as 100 miles (160 kilometers) from the mountains to the valleys and plains. Highland Persia had few large towns until Alexander the Great conquered it. Crafts developed after cities were founded. Pottery, weaving, and metalwork in copper,



Granger Collection

A bronze Persian head was cast in the 1000's B.C.



Granger Collection

Silver drinking cup was used by a king or nobleman.





WORLD BOOK photos by James Simek

Persian coins. The Achaemenid coin, *left,* was minted in the 400's B.C., Sassanian coin, *right,* about A.D. 400.

The winged Ahura Mazda, shown in an image below, was the chief god of ancient Persia and symbol of Zoroastrianism.

Robert Harding Picture Library



iron, gold, and silver became important occupations. Pots and pans became more important than weapons, armor, and farming tools. Potters and weavers made clothing, pottery, and rugs for the people.

Caravans carried trade goods from many parts of th world through Persia to the Mediterranean Sea. Impor tant articles of trade included precious and semipre-cious stones, and spices. A silk route to central Asia an China was opened, probably during the 100's B.C. Trad routes from Mesopotamia to the Far East led across Pe sia, skirting the central desert.

Other routes led east to India, and north to the Cauc sus Mountains and the Black Sea. The Persians built roads between cities in their empire. The most famous of these roads was the royal road that linked Sardis in western Asia Minor to Susa near the Persian Gulf. The Persians used the roads to deliver mail swiftly by relays of horsemen.

Government

Well-organized bureaus governed the Achaemenid Empire (about 550-331 B.C.). The empire was divided int provinces called *satrapies,* each governed by an official called a *satrap.* Satraps ruled and lived like minor kings But the *king of kings,* who ruled the empire from Persia had final and absolute authority. The kings *codified* (sys tematized) the laws in various parts of the empire. Troops in the satrapies were controlled by the central government. A secret service, which the Greeks called the "eyes and ears of the king," informed the king of af-fairs throughout the empire.

Under the Parthians (155 B.C.-A.D. 225) and Sassanids (c. A.D. 224-641), Persians kept the title king of kings. Some of these Persian rulers were strong, but others were weak. Local lords exercised great powers during the Parthian period.

A powerful state church existed under the Sassanids. Priests served in important civil posts, but church and state remained separate.

History

Early civilization. The first known civilization in Per-sia was that of the Elamites, who settled the region per-haps as early as 3000 B.C. Tribes of Medes and Persians wandered into Persia around 1000 B.C. The Medes cre-ated the first state on the Persian plateau about 700 B.C., and reached the height of their power in the late 600's B.C. The Persians, led by Cyrus the Great, overthrew the Medes about 550 B.C.

The Achaemenid Empire. Cyrus enlarged the Me-dian empire by seizing the kingdom of Lydia around 54 B.C. and gradually absorbing Greek colonies in Ionia, in western Asia Minor. He called this the Achaemenid Em-pire, after his ancestor, Achaemenes. He conquered Babylonia in 539 B.C. and freed the Jews in captivity there. They returned to Palestine. Cyrus was killed in 53 B.C. He had created an empire that extended from the Mediterranean Sea and western Asia Minor to the upper Indus River in what is now northern Pakistan, and from the Gulf of Oman to the Aral Sea.

Cambyses, Cyrus' son, conquered Egypt in 525 B.C., but died on his way back to Persia. A civil war for con-trol of the empire followed, and Darius I, a relative of Cambyses, became king in 522 B.C.



SEF/Art Resource

ıvestiture of Ardashir I, a rock relief sculpture of Naqshi-ustam, near Persepolis, shows Ardashir, *left,* founder of the assanid dynasty, taking the symbol of royalty from Ahura lazda, the supreme Zoroastrian god.



Granger Collection

An Achaemenid cylinder seal shows King Darius killing a lion. Impressions were made by rolling the seal across soft clay.

Darius reorganized the government under the satrapy ystem, established the absolute power of the king of ings, and developed a regulated system of taxation. He lso built palaces at Persepolis and Susa, two of his capals. He expanded the Persian Empire into southeastern urope and into what is now southern Pakistan.

About 513 B.C., the Persians invaded the area west and north of the Black Sea, but they did not conquer much land. Darius sent an army into Greece in 490 B.C., but it was defeated by Athenian forces at Marathon. Darius died in 486 B.C., while preparing for new attacks on Greece.

Xerxes, Darius' son, invaded Greece in 480 B.C., and defeated a force of Spartans and other Greeks after a fierce battle at Thermopylae. But the Persians suffered crushing defeats at Salamis and Plataea, and were driven from Europe in 479 B.C. See **Greece, Ancient** (The Persian Wars).

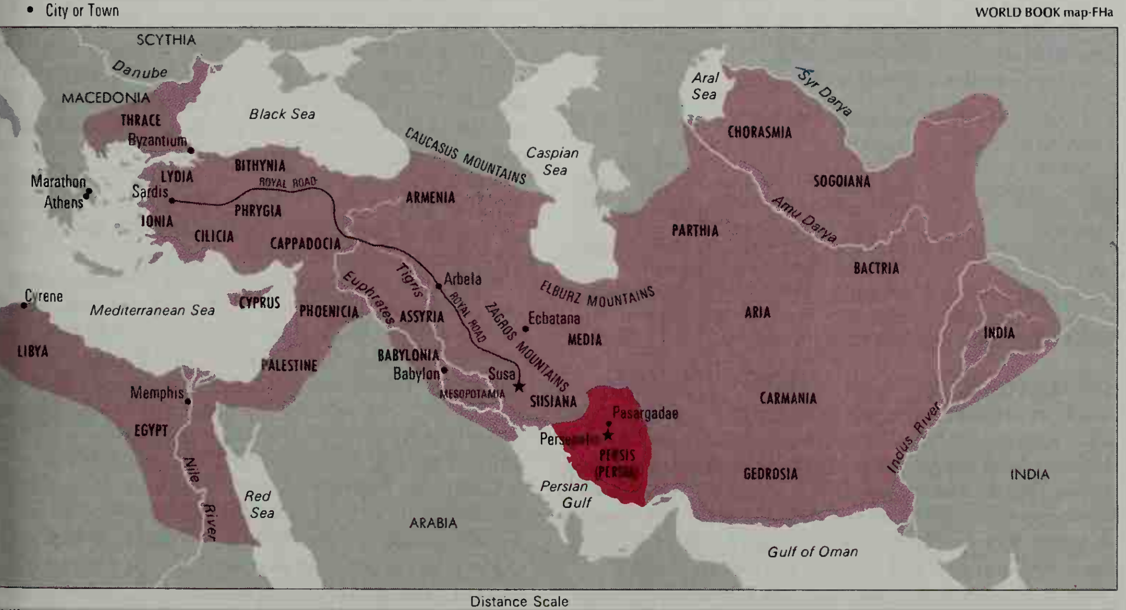
After Xerxes' death, Persia declined. But the empire continued to exist in spite of revolts until 331 B.C., when Alexander the Great defeated a huge Persian army at the Battle of Arbela (sometimes called the Battle of Gaugam-

ersian Empire about 500 B.C.

This map shows the Achaemenid Empire at its peak about 500 B.C., during the reign of Darius I. Persis, later called *Persia,* was the center of an empire that stretched west to the central Mediterranean Sea, east to northwestern India (now Pakistan), and from the Gulf of Oman in the south to the Caucasus Mountains and the Syr Darya River in the north. Darius ruled from several capitals.

Persia
Persian Empire
★ Capital
• City or Town

WORLD BOOK map-FHa



ela). This ended the Achaemenid Empire, and Persia became part of Alexander's empire.

The Seleucid dynasty. More than 10 years after Alexander's death in 323 B.C., one of his generals, Seleucus, started a dynasty that ruled Persia and nearby areas. The Seleucids founded many cities and introduced Greek culture into western and central Asia. In about 250 B.C., the Parthians won control of Persia.

The Parthian Empire lasted until about A.D. 224. The Parthians built a large empire across eastern Asia Minor and southwest Asia. During the last 200 years of their rule, the Parthians had to fight the Romans in the west and the Kushans in what is now Afghanistan. Civil wars erupted in the Parthian Empire.

In about A.D. 224, a Persian named Ardashir overthrew the Parthians and seized the Parthian Empire. After more than 550 years under other rulers, Persians again ruled Persia.

The Sassanid dynasty, named for Sassan, grandfather of Ardashir, ruled Persia until the mid-600's. Wars between Persians and Romans continued through much of the Sassanian reign. After the Romans adopted Christianity in the 300's, the conflict seemed to become a religious struggle between Christianity and Zoroastrianism, the religion of the Persians.

The Sassanian civilization reached its high point in the mid-500's. Persians won several victories over the Romans, and reconquered land that had been part of the Achaemenid Empire. Persian troops advanced to the walls of Constantinople (now Istanbul, Turkey), then the capital of the Byzantine (East Roman) Empire. But they were defeated there and forced to withdraw from all the land they had conquered.

The rise of Islam, a new religion in Arabia, brought a sudden end to the Sassanid dynasty in the mid-600's. Arabs invaded Persia and defeated the Persians in 637 and during the 640's. Islam spread across the Persian plateau. But the new Islamic rulers kept much of Persia's organization, art and architecture, and culture.

For the history of Persia after the Arab conquest, see **Iran (History).** Jack Martin Balcer

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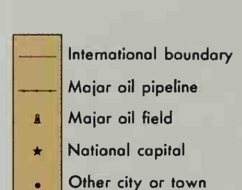
Additional resources

Nardo, Don. *The Battle of Marathon.* Lucent Bks., 1996. *The Persian Empire.* 1997.
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Persian Gulf, *PUR zhuhn,* is a kidney-shaped body of water in southwestern Asia between Iran and the Arabian Peninsula. Arabs call it the *Arabian Gulf.* The Strait of Hormuz links the gulf to the Gulf of Oman, an arm of the Indian Ocean. The Persian Gulf is about 500 miles (800 kilometers) long and averages 125 miles (201 kilometers) in width. It covers about 100,000 square miles (260,000 square kilometers) and is about 300 feet (91 meters) deep at the deepest point. Such sea animals as oysters and shrimp thrive in the gulf.

The gulf is bordered by Iran, Iraq, Kuwait, Saudi Arabia, Bahrain, Qatar, the United Arab Emirates, and Oman. The leading ports include Bandar-e Abbas, Bushehr, and Abadan in Iran; Al Basrah in Iraq; and Kuwait, Dhahran, Doha, Abu Dhabi, and Dubayy (also spelled Dubai) on the Arabian coast.

Persian Gulf







WORLD BOOK map

The gulf region has more than half the world's proved reserves of petroleum and natural gas. Oil and gas from the region power much of the world's industry and earn the gulf states billions of dollars each year.

In ancient times, most towns along the Persian Gulf were self-governing city-states that thrived as ports and trading centers. During the 1800's, the United Kingdom (U.K.) gained influence over much of the region. Some gulf states gained independence in the early 1900's. But the U.K. kept control over the defense and foreign affairs of the rest. By 1971, all of the gulf states were independent, and the U.K. withdrew completely from the area.

During the 1980's, the Persian Gulf was the center of much fighting in a war between Iran and Iraq. It was also the center of fighting in the Persian Gulf War (1991). During the Persian Gulf War, Iraqi troops poured millions of gallons of crude oil into the gulf, causing harm to the body of water (see **Persian Gulf War**).

Robert Geran Landen



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\llied forces attacked from the air, sea, and land during the Persian Gulf War. In January 1991, ıllied aircraft, including the French warplane above, began bombing military targets in Iraq and (uwait, while U.S. ships in the Persian Gulf launched cruise missiles, *top right.* In February, allied jround forces, including Saudi tanks, *bottom right,* quickly defeated Iraq.

'ersian Gulf War, sometimes called *Operation Desert Storm,* was fought in early 1991 between Iraq ınd a coalition of 39 countries organized mainly by the Jnited States and the United Nations (UN). The war took ›lace chiefly in Iraq and the tiny oil-rich nation of Kuvait. These two countries lie together at the northern :nd of the Persian Gulf. Leading members of the coaliion against Iraq included Egypt, France, Great Britain, ›audi Arabia, Syria, and the United States.

The coalition had formed after Iraq invaded Kuwait on \ug. 2, 1990. Iraq's invasion followed unsuccessful atempts to resolve several disputes between the two :ountries. After quickly gaining control of Kuwait, Iraq noved huge numbers of troops to Kuwait's border with ›audi Arabia, triggering fears that Iraq would invade ›audi Arabia next. Iraq's actions were viewed with alarm ›y the world's industrialized countries, which relied on (uwait and Saudi Arabia as a primary source of petroeum. A number of coalition members sent troops to ›audi Arabia to protect it from possible attack.

On Jan. 17, 1991, after months of pressuring Iraq to eave Kuwait, the coalition began bombing Iraqi military nd industrial targets. In late February, the coalition aunched a massive ground attack into Kuwait and outhern Iraq and quickly defeated the Iraqis. Coalition nilitary operations ended on February 28.

The war resulted in immense human suffering in the Aiddle East and enormous material damage in Iraq and Kuwait. Hundreds of thousands of people were killed or wounded or became refugees. Economic measures taken against Iraq caused great hardship in that nation and in other countries in the region. The war also caused severe environmental pollution in the region, as the Iraqis set hundreds of Kuwaiti oil wells on fire and dumped huge amounts of Kuwaiti oil into the Persian Gulf. In addition, the war triggered bloody revolts in Iraq by Kurds and Shiite Muslim Arabs.

David A. Deese, the contributor of this article, is Professor of 'olitical Science at Boston College.

Important dates in the Persian Gulf crisis

1990

Aug. 2 Iraqi troops invaded Kuwait.
Aug. 2 The UN Security Council, in New York City, demanded Iraq's withdrawal from Kuwait.
Aug. 6 The UN Security Council declared an economic embargo against Iraq.
Aug. 8 Iraq announced its annexation of Kuwait. The first United States troops arrived in Saudi Arabia.
Aug. 25 The UN Security Council passed a resolution to allow enforcement of the embargo by military means.
Nov. 29 The UN Security Council authorized the use of "all necessary means" to remove Iraq from Kuwait after Jan. 15, 1991, New York City time.

1991

Jan. 17 Coalition forces began bombing Iraqi targets.
Feb. 24 Coalition forces began a major ground attack.
Feb. 27 Kuwait's capital, Kuwait City, was liberated.
Feb. 28 Coalition attacks against Iraq ended.
April 6 Iraq accepted the terms of a formal cease-fire agreement.
April 11 The UN Security Council officially declared an end to the war.

The Persian Gulf War was the first major international crisis after the end of the Cold War (see **Cold War**). It severely tested cooperation between the United States and the Soviet Union, as well as the ability of the UN to play a leading role in world affairs. The war also split the Arab world between coalition members and supporters of Iraq's president, Saddam Hussein.

Background to the war

Competition for Arab leadership. Saddam Hussein's ambition for power and leadership in the Organization of Petroleum Exporting Countries (OPEC) and in the Middle East was a central cause of the invasion of Kuwait. Besides Iraq, OPEC members also included Kuwait and Saudi Arabia. Like those countries, Iraq was a major oil-exporting nation. But from 1980 to 1988, Iraq had fought a drawn-out war with its neighbor Iran. Iraq suffered serious economic damage in the Iran-Iraq War. Nevertheless, it emerged from that conflict as the second-strongest military power in the Middle East. Only the Jewish state of Israel was stronger.

Hussein argued that Iraq had become the region's chief power opposed to Israel and should thus be recognized by other Arab countries as leader of the Arab world. Since the late 1940's, Arab countries had fought several wars with Israel. Many Arabs wanted to abolish Israel and place its lands under the control of Palestinians and other Arabs.

Hussein claimed that, as leader of the Arab world, Iraq should receive help from other Arab countries in rebuilding its economy. According to Hussein, Iraq needed help from OPEC in raising world oil prices, along with the cancellation of debts that Iraq had incurred to Kuwait and other Arab countries to fight the Iran-Iraq War.

Disputes between Iraq and Kuwait. After the Iran-Iraq War, Hussein had disagreed with Kuwait's leaders over how much debt-cancellation and other financial ai Kuwait should provide for Iraq's economic recovery. Hussein also accused Kuwait of exceeding oil production limits set by OPEC and thus lowering world oil prices. In addition, Hussein claimed that Kuwait was tak ing Iraqi oil from the Rumaila oil field, a large field that lay beneath both Iraq and Kuwait.

Also, Iraq had often claimed that Kuwait should be part of Iraq. Iraq based its claim on the fact that, in the late 1800's and early 1900's, Kuwait had been included ir a province of the Ottoman Empire, called Basra, which later became part of Iraq. But by the time Iraq was formed in the early 1920's, Kuwait was no longer part of the province. Also by the early 1920's, Britain had gainec control of Kuwait and what became Iraq. Iraq became a independent nation in 1932, and Kuwait in 1961. But Irac did not recognize Kuwait's independence until 1963. After 1963, disputes continued between Kuwait and Iraq over the location of the two countries' common border.

What Hussein hoped to gain by taking Kuwait. Saddam Hussein was encouraged by a number of factors to consider an invasion of Kuwait. For example, by seizing Kuwait, Iraq could acquire that country's oil wealth and eliminate the Iraqi debt to Kuwait. Also, Iraq's control of Kuwaiti oil could have greatly increasec Iraq's power within OPEC.

Hussein also sought better access to the Persian Gulf. Iraq's gulf coastline was extremely short. Kuwait's was much longer and included an excellent harbor. In addition, Hussein probably hoped that an invasion would keep Iraq's military occupied and so end a series of attempts by the military to force him out of power.



WORLD BOOK map

The Persian Gulf War was fought mainly by air and land forces in Iraq, Kuwait, and Saudi Arabia and by naval forces in the Persian Gulf. Iraq also launched missile attacks against Israel. Most ground fighting occurred in desert regions.

Iraq's invasion of Kuwait

At 2:00 a.m. on Aug. 2, 1990, hundreds of tanks and other Iraqi forces swept across the Kuwaiti border. Within 24 hours, Iraq had complete control of Kuwait. Thousands of Iraqi troops then moved to Kuwait's border with Saudi Arabia. To some, this movement signalec that Iraq might invade Saudi Arabia. On August 8, Iraq announced that it had annexed Kuwait.

Under international law, none of Iraq's claims against Kuwait justified its invasion of that country. The United Nations, as well as the United States and many other countries, condemned the Iraqi invasion. Hussein, however, accused the United States and other nations of following a double standard in their reaction. According tc Hussein, if these nations condemned the Iraqi invasion, they should also condemn Israel's continuing occupation of lands it had won from Arab nations in the Arab-Israeli wars. Since the 1970's, the United States had beer Israel's chief ally.

Arabs in many countries supported Iraq's invasion of Kuwait—particularly poor Arabs and Palestinians. Hussein became a hero to numerous Arabs by confronting Israel and the United States. He gained additional support from poor Arabs by calling for the redistribution of the vast wealth of Kuwait, Saudi Arabia, and certain other Arab oil-exporting nations.

The world's reaction

On August 2, at UN Headquarters in New York City, the UN Security Council issued a resolution condemn-

ıg Iraq's invasion. Soon after the invasion, U.S. Presi-
ent George H. W. Bush and other world leaders began
vorking to form an anti-Iraq coalition. The coalition
ventually grew to include Afghanistan, Argentina, Aus-
-alia, Bangladesh, Belgium, Canada, Czechoslovakia,
enmark, France, Germany, Greece, Honduras, Hun-
ary, Italy, the Netherlands, New Zealand, Niger, Nor-
vay, Pakistan, Poland, Portugal, Senegal, Sierra Leone,
ingapore, South Korea, Spain, Sweden, Turkey, the
Jnited Kingdom, and the United States. Arab members
f the coalition were Bahrain, Egypt, Kuwait, Morocco,
)man, Qatar, Saudi Arabia, Syria, and the United Arab
mirates. South Korea was the only coalition member
ıat was not also a member of the UN. The Arab coun-
ies of Jordan, Libya, and Yemen opposed the involve-
ıent of non-Arab countries but did not fight against the
oalition. China and the Soviet Union, at that time the
vorld's most powerful Communist countries, did not
ɔin the coalition. But their cooperation as members of
ıe UN Security Council allowed the UN to play a lead-
ıg role in the crisis.

Measures against Iraq. On August 6, the UN Securi-
/ Council imposed an embargo that prohibited all trade
vith Iraq except for medical supplies and food in certain
ircumstances. Nearly all of Iraq's major trading partners
upported the embargo. As a result, Iraq's foreign trade
ll but ended. On August 7, the United States an-
ounced that it would send troops to the Persian Gulf to
lefend Saudi Arabia from possible attack by Iraq.

In mid-August, Iraq began detaining various foreign
itizens who had been living in Iraq or Kuwait. These
ostages included foreign diplomats in Kuwait. Hussein
ıter ordered these people moved to military and indus-
ial sites in Iraq, where they would serve as "human
hields" to discourage attacks by coalition members. By
nid-December, however, Iraq had released all the
ostages under pressure from other countries, includ-
ıg several key Arab nations.

On August 25, the UN Security Council authorized the
ıse of force to carry out the embargo against Iraq. On
Jovember 29, the council gave coalition members per-
ıission "to use all necessary means" to expel Iraq from
uwait if Iraq did not withdraw by Jan. 15, 1991. Iraq
hose to stay in Kuwait.

The opposing forces. By mid-January, the coalition
ad about 670,000 troops, 3,500 tanks, and 1,800 combat
ircraft in the Persian Gulf region. The troops came from
8 coalition members and included about 425,000
-oops from the United States. Many of the rest of the
-oops came from the United Kingdom and France and
uch Arab countries as Egypt, Saudi Arabia, and Syria.
Coalition members that did not send troops provided
quipment, supplies, or financial support. The coalition
lso had about 200 warships in the Persian Gulf region,
ıcluding 6 U.S. aircraft carriers and 2 U.S. battleships.
-aq had between 350,000 and 550,000 troops in Kuwait
nd southern Iraq, with about 4,500 tanks and 550 com-
at aircraft. It also had a small navy.

The coalition takes military action

Militarily, the coalition first tried to force Iraq to with-
raw from Kuwait by bombing Iraqi military and indus-
ial targets. But after more than five weeks of heavy
ombing, Iraq still refused to withdraw. The allies then
started a major ground attack against Iraqi forces.

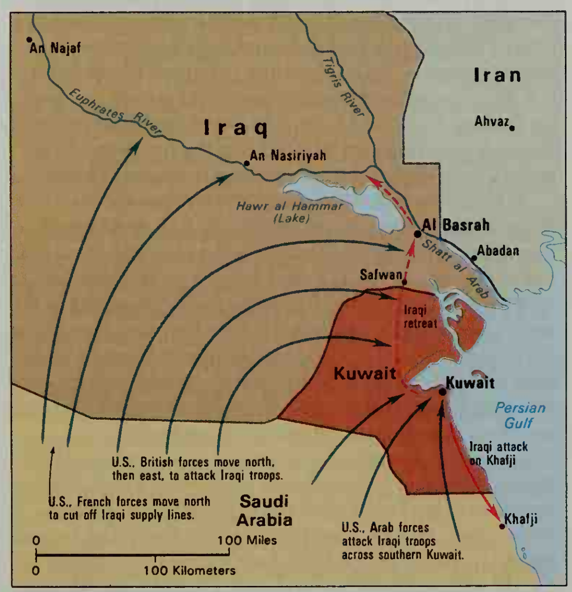


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Weeks of bombing by allied aircraft left much of Baghdad, Iraq's capital, in ruins. Residents of the city lacked electricity and running water during most of the war.

The air war began at 3 a.m. on Jan. 17, 1991. The coalition aimed first to destroy Iraq's ability to launch attacks. Other goals included eliminating Iraq's biological, chemical, and nuclear weapons facilities; gaining superiority over Iraq's air force; disrupting Iraq's ability to gather information about coalition forces and to communicate with its own forces; and reducing the readiness of Iraqi troops in Kuwait and southern Iraq.

Allied aircraft first bombed Baghdad, the capital of Iraq, and then attacked targets throughout Iraq and Kuwait. The allies gradually focused heavy bombing on



WORLD BOOK map

The allied ground attack included three major movements. In two of them, coalition forces attacked Iraqi troops in Kuwait or southern Iraq. In the other, allied forces charged north into Iraq to cut off Iraqi supply lines.



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Oil wells burned out of control in Kuwait after retreating Iraqi troops set fire t hundreds of wells. The dens smoke from the fires darkened the skies in Kuwait and caused serious air pollution Iran, Iraq, Kuwait, and other parts of west and southwest Asia.

Iraqi troops; artillery and tanks; transportation routes; and supplies of ammunition, food, fuel, and water.

The coalition achieved many of its objectives in the air war, in part due to the use of such high-technology equipment as night-vision systems and precision-guided weapons. These weapons included extremely accurate cruise missiles launched from U.S. ships in the gulf.

Iraq's response. Iraq responded to the start of the air war by launching "Scud" missiles at populated areas in Israel and Saudi Arabia. The Scuds were crude and inaccurate by Western standards. But they terrorized the populations of targeted cities and killed a number of people in both Israel and Saudi Arabia.

Analysts believe that Iraq used the attacks on Israel to try to draw it into the war. Had Israel struck back, Iraq might have succeeded in forcing Arab countries out of the coalition by portraying the war as an Arab-Israeli conflict. However, Israel did not enter the war, thus making it much easier to keep the coalition together.

The ground war. The first major ground battle occurred at Khafji, a small Saudi Arabian coastal town near Kuwait. The Saudis had deserted the town before the war. On January 29, Iraqi troops occupied Khafji. With U.S. help, Saudi and Qatari troops recaptured the town on January 31. By late February, the air war had reduced, through casualties and desertions, the number of Iraqi troops in Kuwait and southern Iraq to about 183,000.

At about 4 a.m. on February 24, coalition forces launched a major ground attack into Iraq and Kuwait. The attack consisted of several large operations carried out at the same time. U.S. and French troops invaded Iraq from Saudi Arabia, west of Iraqi fortifications in Kuwait. They moved rapidly north into Iraq and toward the Euphrates River to cut off Iraqi supply lines and to prevent an Iraqi retreat. U.S. and British troops also crossed into Iraq from Saudi Arabia. They moved north into Iraq and then swept east to attack the Iraqi troops.

In another operation, coalition troops assaulted Iraqi forces at several points across southern Kuwait. These coalition troops consisted of U.S. marines and troops from Egypt, Kuwait, Saudi Arabia, and Syria. The troops quickly broke through Iraqi fortifications, and about 63,000 Iraqi soldiers surrendered. On February 26, Hussein ordered his troops to leave Kuwait. But by that time, the Iraqi forces had been surrounded. The coalition ended all military operations at 8 a.m. on February 28, about 100 hours after the ground attack had begun.

The war ends. Iraq accepted the terms of a formal cease-fire agreement on April 6. On April 11, the UN Security Council officially declared an end to the war. In the cease-fire agreement, Iraq promised to pay Kuwait for war damages. Iraq also agreed to the destruction of all its biological and chemical weapons, its facilities for producing such weapons, and any facilities or materials it might have for producing nuclear weapons. Iraq did not yet have nuclear weapons, but it was trying to produce them. Iraq stockpiled chemical weapons in Kuwait before the ground war, but there is no evidence that either side used chemical weapons during the war. Neither side used biological or nuclear weapons.

After the formal cease-fire, the UN continued the embargo to pressure Iraq to carry out its promises. However, Iraq stubbornly resisted complying with the terms of the cease-fire agreement.

Consequences of the war

As many as 100,000 Iraqi troops may have died as a result of the war, but some experts believe the total is much lower. Deaths of coalition troops totaled only about 370. Thousands of civilians in Iraq and Kuwait probably were also killed during the war. Many other Iraqi civilians later died as a result of wartime destruction or because of revolts triggered by Iraq's defeat.

Coalition bombing severely damaged Iraq's transpor-



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A joyful Kuwaiti, *center,* greeted Arab troops who led the allied forces that liberated Kuwait City. Iraqi troops ended their occupation of the city after allied forces defeated them.

ation systems, communication systems, and petroleum nd other industries. Coalition attacks also wiped out nuch of Iraq's ability to provide electric power and lean water. As a result, many civilians died after the war rom disease or a lack of medicine or food.

In Kuwait, Iraqi troops looted the country and damged many of Kuwait's oil wells, in most cases by setting hem on fire. In addition, Iraq dumped an estimated 465 nillion gallons (1.75 billion liters) of Kuwaiti crude oil nto the Persian Gulf, killing wildlife and causing longerm harm to the environment.

After the war, Saddam Hussein continued to rule Iraq. ut revolts broke out among Kurds in northern Iraq and, n southern Iraq, among Arabs of the Shiah division of he Muslim religion. Both groups had long opposed lussein's rule. Iraq's army swiftly put down most of the ebellions. Hundreds of thousands of Shiite Arabs then ed to Iran. Thousands of others hid in the marshlands f southern Iraq. More than a million Kurds fled to the nountains of northern Iraq and to Turkey and Iran. Tens f thousands of Kurds and Shiites were killed in the reolts or died later of disease, exposure, or hunger.

In April 1991, the United States and other coalition nembers established a safety zone in northern Iraq to rotect the Kurdish refugees from Iraqi troops. Coalition orces remained in northern Iraq until July. But coalition ircraft continued to patrol northern Iraq as part of an ffort to enforce a ban on Iraqi aircraft flights and troop novements there. In 1992, to protect the Shiite population, coalition forces imposed a ban on Iraqi aircraft lights over southern Iraq. In 1996, Iraqi troops attacked urds in northern Iraq. The United States responded vith missile attacks against Iraqi military targets.

The Persian Gulf War also focused world attention on he Arab-Israeli conflict. Following the war, the United tates renewed diplomatic efforts to resolve disputes etween Israel and the Arab countries. These efforts elped lead to the signing of several peace agreements etween Israel and the Palestine Liberation Organizaon, a group that represents Palestinian Arabs.

The war also proved that significant new forms of inernational cooperation were possible in the post-Cold Var era. Cooperation between the United States and the oviet Union, along with China's support, allowed the JN to take effective action against Iraq.

After the war, some veterans complained of physical nd psychological ailments that they believed were reated to their service. Their symptoms, sometimes reerred to together as Gulf War syndrome, included nemory loss, fatigue, and joint pain. Some people beeved that exposure to dangerous chemicals when U.S. roops destroyed a chemical weapons depot in Iraq may ave affected the troops. Others argued that the synlrome was not a single illness and that the symptoms esulted from the stress of war or other factors.

David A. Deese

Related articles in *World Book* include:

ir force (Air forces in limited wars)
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ulf War syndrome
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Powell, Colin L.
Saudi Arabia (History)
Schwarzkopf, H. Norman
United Nations (The Persian Gulf War)



WORLD BOOK illustration by Kate Lloyd-Jones, Linden Artists Ltd.

Persimmons are pulpy, edible fruits that grow on persimmon trees. The *kaki* or *Japanese persimmon, above,* has large, shiny, dark green leaves.

Persimmon is the name of more than 200 species of small trees that belong to the ebony family. Two species are grown for their pulpy, edible fruits, also called *persimmons.* They are the *kaki* or *Japanese persimmon* and the *common persimmon.* The kaki is native to central and northern China. The common persimmon is native to the southeastern United States. Both the kaki and the common persimmon are grown in the United States. The kaki is more important commercially. It has large, shiny, dark green leaves and yellowish-green flowers. The trunk is usually straight, but the branches twist.

Persimmon fruits are round or egg-shaped and range from $\frac{1}{2}$ to 2 inches (1 to 5 centimeters) in diameter. They usually are yellowish or orange but may be streaked with red. They contain a strong astringent that causes a person's mouth to pucker. A persimmon tastes best when it is so ripe that it looks wrinkled and almost spoiled. Then it has a sweet, fruity flavor. American Indians made a kind of bread by mixing persimmon pulp with crushed corn. J. Massey

Scientific classification. Persimmons belong to the ebony family, Ebenaceae. The scientific name for the common persimmon is *Diospyros virginiana.* The kaki is *D. kaki.*

Person, in grammar, is the feature of a language that shows the difference between the speaker, the person spoken to, and a person or thing spoken about. If a word stands for the speaker, it is in the *first person.* If it stands for the person spoken to, it is in the *second person.* If it stands for any other person or thing (the person or thing spoken about), it is in the *third person.* English shows person by a change in the form of a personal pronoun or verb. Nouns are third person.

Different forms of personal pronouns show person. *I* and *we* are first person. *You* is second person. *He, she, it,* and *they* are third person.

Regular verbs change form to show person only in the third person, singular, present tense. An *-s* or *-es* is added to the first (or second) person, singular, present tense, to form the third person. I *drive* is first person, you *drive* is second person, but he *drives* is third person. The most irregular verb, *be,* changes form to show person in singular, present tense as follows: I *am,* you

are, he *is.* But plural forms of *be* in the present tense are the same: we *are,* you *are,* they *are.* First and third person forms of *be* in the singular, past tense are alike: I *was* is first person; he *was* is third person. All plural and second person forms use *were:* we, they, you *were.*

Sara Garnes

See also **Declension; Pronoun; Verb.**

Personal property is one of the two classes into which all property may be divided. The other class, called *real property,* consists of such immovable objects as land and the houses, trees, and other objects attached to land. *Personal property* includes all other kinds of property, such as furniture, livestock, and harvested crops. The transfer of personal property is easier than the transfer of real property. Real property must be transferred in writing, but personal property may be transferred orally. Joel C. Dobris

Related articles in *World Book* include:

Administrator	Contract	Heir	Property tax
Bill of sale	Fixture	Next of kin	Real estate

Personality is a term that has many general meanings. Sometimes the word refers to the ability to get along well socially. For example, we speak of glamour courses designed to give a person "more personality." The term also may refer to the most striking impression that an individual makes on other people. We may say, "She has a shy personality."

To a psychologist, personality is an area of study that deals with complex human behavior, including actions, emotions, and *cognitive* (thought) processes. Personality psychologists study the enduring patterns of behavior that make individuals different from one another. Personality psychologists try to learn how these patterns develop, how they are organized, and how they change.

The nature of personality

Personality types. For hundreds of years, people have tried to group the vast differences among human beings into simple units. Some of the resulting groupings divide people into personality types based on certain characteristics.

The ancient Greek physician Hippocrates divided individuals into such types as *sanguine* (cheerful) and *melancholic* (depressed). He attributed their behavioral differences to a predominance of one of the body fluids. For example, a person was cheerful if blood *(sanguis)* was the dominant influence on his or her behavior.

Some of the more recent theories about personality types have tried to associate body build and temperament. Classifications of personality types based on body measurements were developed by two psychiatrists, Ernst Kretschmer of Germany and William Sheldon of the United States.

The Swiss psychologist Carl G. Jung, who studied psychological characteristics, classified people as *introverts* or *extroverts.* Introverts are more interested in their own thoughts and feelings than in the world around them, and extroverts are the reverse. See **Extrovert; Introvert.**

The simplicity of personality-type theories is appealing, but it also limits their value. An individual's behavior is so complex, diverse, and variable that the person cannot be sorted usefully into a simple category.

Personality traits. Related to personality-type theories is the search for broad traits or dispositions to describe enduring differences among people. Personality traits are regarded as dimensions that range from high to low. For example, anxiety is a trait that varies from the greatest anxiety to the least anxiety. Most people have some degree of anxiety along the scale between the two extremes. Psychologists have studied such personality dimensions as aggressiveness, dependency, and extroversion-introversion. People differ greatly in the degree to which they show such traits.

Studies of personality traits help reveal the relationships between an individual's standing on different personality dimensions. In one type of study, for example, psychologists give people questionnaires about their attitudes. The psychologists then rate the people on psychological traits to see if there is a relationship between having certain attitudes and possessing certain traits.

Ratings and self-reports. Research on personality traits tends to rely heavily on broad ratings of personality. In self-ratings, a person indicates the degree to which he or she thinks he or she possesses certain personality characteristics. Ratings may also be obtained from teachers, or others who know the person or who have watched the person in special situations.

These judgments may be affected by many types of bias. A person may give the responses that he or she thinks are expected and socially desirable, even if they are not true. Moreover, the answers may reflect preconceptions and *stereotypes* (fixed ways of thinking), rather than an accurate description of behavior. Tests that ask a person to rate such attributes as friendliness or adjustment provide broad self-characterizations rather than detailed descriptions of behavior. Consequently, the findings of such tests may partly reveal the concepts and stereotypes that people apply to themselves and to others. These findings may not necessarily reflect the people's actual behavior outside the test.

Some techniques are designed to reduce the role of personal meanings and concepts. Other approaches deliberately seek to clarify the individual's concepts about himself or herself. These personal concepts are especially important in theories that stress the role of the self and one's image of oneself. For example, the theory of *self-actualization* developed by the American psychologist Carl R. Rogers focuses on *phenomenology*—a person's private experiences and perceptions of the self, others, and the environment.

Projective tests. Some investigators have tried to avoid the problems of relying on a person's ratings or reports about himself or herself by creating indirect clinical techniques in the form of projective tests. These methods require the person to respond to a stimulus in relation to which there are no clear guidelines and no right or wrong answers. The person may be asked how inkblots appear on the Rorschach Test. Or the person may be told to create a story about the characters in a series of pictures in the Thematic Apperception Test. Projective techniques rely on a trained clinician to interpret the test. The value of such techniques for revealing personality is controversial and is still being studied.

Freud's psychoanalytic theory. According to the Austrian physician Sigmund Freud, the personality has three parts: (1) the *id,* which represents instinctive impulses of sex and aggression; (2) the *ego,* which repre-

sents the demands of the real world; and (3) the *super-ego,* or conscience, which represents standards of behavior incorporated into the personality during childhood.

According to Freud, mental life is characterized by internal conflicts that are largely unconscious. Impulses from the id seek immediate gratification, but they conflict with the ego and the superego. When unacceptable impulses threaten to emerge, a person experiences anxiety. To reduce this anxiety, the person may use various personality defenses. The person may, for example, *displace* (transfer) his or her emotions to less threatening objects. A child who is afraid to express aggression toward his or her father may become angry at his or her pet dog instead.

Freud's ideas have had great influence on the study of personality, but they are highly controversial. Many of his ideas had to be modified by psychologists to take greater account of social and environmental variables. See **Developmental psychology.**

Personality and environment

Trait theories and psychoanalytic theories both assume that broad internal personality dispositions determine behavior in many situations. However, research on the consistency of various personality traits indicates that what people do, think, and feel may depend greatly on the specific conditions in which their behavior occurs.

People may be honest in one situation and dishonest in another. They may be passive in some situations but aggressive in other situations or with different people. Many contemporary approaches to the study of personality therefore emphasize the role of specific social experiences and environmental events in the development and modification of behavior. Psychologists following this approach study the ways people categorize situations. Regularities and irregularities in behavior are then understood in terms of the person's perception of similarities and differences among situations.

Personality development. Some psychologists have examined the effects of early experiences on later personality development. Other investigators have studied the stability of particular patterns of personality over long periods of time. Their findings suggest that such tendencies as striving to achieve may persist to some degree from childhood into adulthood. However, research has also shown that personality continues to change as a result of new experiences and modifications in the environment.

Throughout their development, people learn about themselves and their world by observing other people and events. They also learn by trying new kinds of behavior directly. The rewards and punishments they receive after trying various patterns of behavior affect their future behavior in similar situations. People also learn by observing the results of the behavior of such social models as their parents. Suppose children repeatedly see adults succeed in antisocial or criminal acts. If they see such behavior rewarded, they are more likely to copy it than if it is punished or leads to no clear consequences. Children more readily imitate models who are powerful or who reward or take care of them.

As children develop, they copy some of the behavior of many models, including their friends as well as their parents. They combine aspects of their behavior into new patterns. Through direct and observational learning and cognitive growth, they also acquire standards and values that help them regulate and evaluate their own behavior. Gradually, people develop an enormous set of potential behaviors. The particular behavior patterns they show in specific situations depend on motivational factors. See **Motivation.**

People's cognitive and social learning experiences vary as a result of the particular social and cultural conditions to which they are exposed in the home, at school, and in other environments. Personality traits may predict many important aspects of behavior. But the setting in which behavior occurs often provides the best predictions about what people will do. Thus, although extensive differences among people are found in most human actions, considerable uniformity and regularity can occur when environmental conditions are very powerful. Strong success experiences in a new situation, for example, may override the effects of past failure experiences and of personality traits in determining future reactions to that new situation.

Emotional reactions. During the course of development, we acquire intense emotional reactions to many stimuli. Events that once were neutral may become either pleasurable or painful as the result of conditioning (see **Learning** [How we learn]).

Some reactions may involve strong anxiety and can have crippling effects. For example, children who have frightening experiences with dogs may become afraid of all dogs. This fear may *generalize* (spread) even more widely to other animals and to such objects as fur coats, for example, or hair. Such fears are especially hard to unlearn because these people tend to avoid all contact with situations that provoke fear. Consequently, these people prevent themselves from having experiences that might eliminate their fear—petting harmless dogs, for example. Emotional upsets of this kind may also be acquired by observing the fear reactions of other people.

As a result of social learning, we generalize from our experiences to new but similar or related situations. But we do not generalize indiscriminately. A young boy may learn to express physical aggression in many settings, including school, play, and home. But he also learns not to be aggressive in other situations, as when visiting his grandparents.

Personality change. Research on cognitive and social learning processes is leading to new forms of psychotherapy to help people who have psychological problems. Some of these problems are the result of learning deficits. For example, some people lack fundamental academic and vocational skills, such as reading proficiency. Individuals who have inadequate relations with others need to learn essential interpersonal skills. Some people have these basic skills, but they suffer because of emotional fears and inhibitions.

Psychoanalytic therapy to change personality tends to stress insight into the history through which the problems developed. Learning methods try to change the disturbing behavior itself by carefully planned relearning and conditioning techniques. Still other forms of personality change may be achieved by creating special

environments for learning personality patterns that are more adaptive. Lawrence A. Pervin

Related articles in *World Book* include:

Abnormal psychology	Psychology
Alienation	Social psychology
Behavior	Social role
Freud, Sigmund	Sullivan, Harry S.
Perception	Testing

Personnel management is a field of management that involves using workers' skills effectively and making their jobs rewarding. Nearly all large businesses and other organizations have a department responsible for personnel management. The field is also called *employee relations* or *human resources management.* In organizations that have many employees who belong to a union, personnel management is often known as *industrial relations* or *labor relations.* Its chief function in such a company is to represent the firm in contract talks and other dealings with the union.

Specialists in personnel management have a wide range of responsibilities. They interview, test, and recommend applicants to fill job openings. They organize recruiting campaigns and travel to high schools and colleges to search for promising applicants. These managers develop pay scales, systems for evaluating employee performance, and training programs to teach workers and managers new skills. They administer employee benefits, such as health insurance, life insurance, and pensions. They offer counseling to help employees solve personal or work-related problems. Personnel managers also supervise affirmative-action plans, including special recruiting and training programs for women and minority groups (see **Affirmative action**).

Development of personnel management. In the 1800's and early 1900's, personnel management was a simple activity that involved little more than hiring employees. Hiring was easy in the United States because many immigrants were competing for jobs.

Personnel management grew in complexity and importance during the mid-1900's. People began to recognize that worker morale affects productivity and that most workers need more than reasonable wages to be happy in their job. For example, employees also require recognition, a feeling of achievement, and an opportunity to participate in decisions that affect their work. Personnel managers helped meet these needs by such means as company newsletters, recreation programs, and suggestion systems. Labor unions became more powerful, and the field of industrial relations expanded greatly. The Social Security Act of 1935 also created additional responsibilities for personnel managers, who supervised the retirement and unemployment benefits established by the act.

In the 1960's and 1970's, many new federal laws directly affected the relationship between an organization and its employees. These laws included the Civil Rights Act of 1964, the Occupational Safety and Health Act of 1970, and the Employee Retirement Income Security Act of 1974 (ERISA). Organizations relied heavily on personnel managers to help them follow federal regulations regarding minority hiring, pensions, worker safety, and other matters.

Careers in personnel management. Many colleges and universities offer courses in personnel management. Students who desire a career in this field should also study such subjects as accounting, computer science, law, marketing, and psychology. The American Society for Personnel Administration, a professional association for personnel managers in the United States, sets professional standards. Daniel Quinn Mills

See also **Industrial psychology; Industrial relations; Human relations.**

Perspective is a technique used by artists to give a picture the illusion of depth and distance. When observing a picture done in perspective, viewers have the impression that they are looking through a window. The sides of the picture serve as the "window frame." The scene appears to recede into the distance from a fixed point on the viewer's side of the window.

There are two major types of perspective in Western art—*aerial perspective* and *linear perspective.* Non-Western civilizations, such as those of China and India, have also developed styles of perspective. However, the Eastern styles do not produce an effect as realistic as the Western techniques.

Aerial perspective is based on the fact that light, shade, and color change with an object's distance from the viewer. For example, distant objects appear hazier and less sharp in outline than objects seen nearby. The sky also changes from a deep blue directly overhead to an increasingly lighter blue as it approaches the horizon. An artist creates aerial perspective by varying the color tones and the strength and sharpness of the picture's lines.

Linear perspective is a technique for showing distance and depth through the form, size, and position of objects. Linear perspective is based on the optical illusion that parallel lines seem to converge as they recede toward a *vanishing point.* A vanishing point is the spot at which the parallel lines appear to meet on the horizon. Linear perspective also creates the illusion of depth by making the more distant objects smaller and placing them closer together.

Artists in ancient Greece and Rome were the first to understand the principles of both aerial and linear perspective. Both techniques were largely abandoned during the Middle Ages, which began during the A.D. 400's. But perspective was rediscovered during the Renaissance, a cultural period that began in Italy during the 1300's.

Interest in perspective reached its peak in the Renaissance paintings of the 1400's and 1500's. About 1425, the Italian architect Filippo Brunelleschi painted two scenes of the city of Florence that used mathematical formulas to create perspective. His work had a great impact on Renaissance artists, who became fascinated with using perspective to achieve realism in portraying space. Leon Battista Alberti, another Italian architect, wrote *On Painting* (1435), the first scientific study of perspective. The Italian artist and scientist Leonardo da Vinci performed many experiments that explored how the eye sees objects at a distance. Samuel Y. Edgerton, Jr.

For examples of perspective in art, see **Bellini, Giovanni; Raphael; Masaccio;** and various paintings in the **Painting** article.

Perspiration, *PUR spuh RAY shuhn,* also called *sweat,* consists of water and certain dissolved substances produced by glands in the skin. Sweat glands are distrib-

ted over the entire surface of the body. But in certain reas they are larger and more concentrated. For example, there are many large sweat glands in the armpits, n the palms of the hands, and soles of the feet. The weat glands are of almost no importance in ridding the ody of waste materials. Their primary importance is to roduce perspiration when the body needs to lose heat. weating itself does not reduce body heat. But when the weat evaporates, it has a cooling effect. See **Evaporaon; Temperature, Body.**

People perspire in cool weather as well as in warm, at ght as well as during the day. When it is cool, the nall amount of sweat produced evaporates almost as oon as it is formed. This is called *insensible* perspiraon. When the weather is warm, or during strenuous excise, the sweat glands increase their production. Then rops of water accumulate on the skin and we say a peron is sweating. This is called *sensible* perspiration.

The *hypothalamus* (part of the brain which has the ody's heat-regulating center) keeps body temperature onstant. It receives impulses from warm blood and om heat receptors in the skin. It sends signals by way f the nerves to the sweat glands, which then produce weat. Nervous tension and excitement also activate the weat glands, especially in the hands and armpits.

When the water of perspiration evaporates, certain olids (urea and salts) are left on the skin. Frequent athing will keep these solids from accumulating and ogging the pores. Excess sweating in the armpits can e counteracted by applying various substances sold for is purpose. Most of these contain aluminum chloride.

Many animals do not reduce body heat in the way at human beings do. For example, a dog has sweat ands, but they are not important in reducing the body temperature. Many persons believe that a dog perspires through its mouth. But a healthy dog rarely perspires. Instead, it cools itself by panting. Nandalal Bagchi

See also **Deodorant; Elimination; Pore; Skin.**

Perth (pop. 1,244,320) is the capital and business center of the state of Western Australia. It lies along the Swan River, near the west coast of Australia. For location, see **Australia** (political map).

The main business district of Perth is on the north bank of the Swan River, 12 miles (19 kilometers) northeast of Fremantle, a port city that borders the Indian Ocean. King's Park, which is west of Perth's main business district, includes a 1,000-acre (405-hectare) area of vegetation known as *bush.*

Perth has a warm, sunny climate. Boating in the Swan River and swimming at sandy beaches along the coast are popular recreational activities. A cultural center, which includes a museum, art gallery, and reference library, is just north of the business district. A major casino complex was opened in 1985.

The major industrial plants are far from the center of the city. Refineries process bauxite, nickel, and oil from deposits in the state. Other industries include boatbuilding, tanning, and cement and steel production. Tourism is also an important economic activity.

Perth was founded in 1829 by James Stirling, a British naval officer. The city grew rapidly after settlers discovered gold east of the area in the late 1800's. During the 1960's, other mining discoveries led to further growth and much industrial expansion. Many office buildings and hotel complexes were erected in Perth during the 1980's. R. E. Cronin

See also **Australia** (picture: A street scene in Perth).

Pertussis. See **Whooping cough.**



Paint and gold on vellum (about 1450-1500) by Simon Marmion; Huntingdon Library, San Marino, California

rial perspective creates an illusion of distance rtly by emphasizing dark blue sky directly overad and a lighter blue sky near the horizon.



The Martyrdom of Savonarola (1400's-1500's), an oil painting on wood panel by an unknown Italian artist (SCALA/Art Resource)

Linear perspective makes more distant objects smaller and places them closer together. The center of the painting shown above illustrates the *vanishing point,* the spot at which parallel lines seem to meet in the distance.



Loren McIntyre from Woodfin Camp, In

A pack train of llamas transports goods in the rugged Peruvian Andes. Peru has great extremes in landscape and climate, ranging from snow-capped mountains to steaming jungles.

Peru

Peru, *puh ROO,* is the third largest country in South America. Only Brazil and Argentina cover a greater area. Peru is a land of enormous contrasts in landscape and climate. The country lies in western South America along the Pacific Ocean. The long, narrow coast consists of a desert even drier than the Sahara. Most of Peru's large cities lie in this region, including Lima (pronounced *LEE mah),* the capital and largest city. The towering, snow-capped Andes Mountains rise east of the coast and extend north and south down the entire length of the country. This region is famous for its grass-covered plateaus, crystal-clear air, and sparkling sunshine. Thick rain forests and jungles cover most of the hot, humid region east of the Andes.

More Indians live in Peru than in any other country in South America. The Indians make up nearly half of the country's people and about a fifth of the total Indian population of North and South America. The rest of Peru's population consists mainly of people of mixed Indian and white ancestry. Whites make up only a small part of the country's population.

Peru is one of the world's leading producers of copper, lead, silver, and zinc. It also ranks among the world's leading fishing countries. But most of Peru's people are poor. Many of them make a bare living farming. Other Peruvians work for low wages in the cities or are unemployed.

The ancestors of Peru's Indians include the famous Inca Indians, who built a great empire in Peru from the 1200's to the 1500's. The first white people reached the country in the 1520's, led by the Spanish adventurer Francisco Pizarro. They conquered the Inca in the 1530's and made Peru a Spanish colony. Peru declared its independence from Spain in 1821.

David J. Robinson, the contributor of this article, is DellPlain Professor of Latin American Geography at Syracuse University.

Government

Peru has had a number of constitutions since it became independent in 1821. The latest constitution was adopted in 1993. Each constitution declared the country to be a democratic republic. Yet dictatorships have ruled Peru many times, including during the period from 1968 to 1980. In 1968, a group of Peruvian military leaders overthrew the constitutionally elected leaders of Peru

Facts in brief

Capital: Lima.
Official languages: Spanish and Quechua.
Official name: República del Perú (Republic of Peru).
Area: 496,225 mi² (1,285,216 km²). *Greatest distances*— north-south, 1,225 mi (1,971 km); east-west, 875 mi (1,408 km). *Coastline*—1,448 mi (2,330 km).
Elevation: *Highest*—Huascarán, 22,205 ft (6,768 m) above sea level. *Lowest*—sea level along the coast.
Population: *Estimated 2002 population*—26,490,000; density, 53 per mi² (21 per km²); distribution, 72 percent urban, 28 percent rural. *1993 census*—22,048,356.
Chief products: *Agriculture*—bananas, coffee, cotton, potatoes, sugar cane. *Fishing*—anchovies, sardines. *Manufacturing*—fish meal, metals, sugar, textiles. *Mining*—copper, iron ore, lead, petroleum, silver, zinc.
Money: *Basic unit*—new sol. One hundred centimos equal one new sol.

ıd took control of the government. The military leaders ıspended the Constitution, dismissed the legislature, ıd canceled all elections. In 1980, elections were held r a new democratic civilian government, including a ·esident and a legislature. The new government re- aced the revolutionary government.

In 1992, President Alberto Fujimori suspended the ɔnstitution, dissolved the legislature, and began to rule ·ru by decree. Later that same year, a Constituent As- ·mbly was elected. The Assembly wrote a new consti- tion for Peru that took effect in December 1993. Demo- atic presidential and legislative elections took place in 95.

National government. Under the Constitution of 93, a president serves as head of state and head of the ›vernment. The president is elected by the people to a e-year term and can be reelected only once. In addi- ɔn, the people elect two vice presidents. The president points a Council of Ministers. A one-house Congress responsible for making the country's laws. The 120 embers of the Congress are elected by the people to e-year terms. The Supreme Court is Peru's highest urt.

Local government. Peru is divided into 12 regions, departments, and the constitutional province of llao. The departments are further divided into ovinces, and the provinces are divided into districts.

The armed forces—especially the army—have tradi- nally played an important role in Peruvian life. Besides ing deeply involved in politics, members of the med forces assist in such activities as police work and adbuilding.

The army, navy, and air force in Peru total about 5,000 people. The officers rank among the best- ined and best-educated officers in the world. Peru has army reserve with about 190,000 members. Military rvice is voluntary.

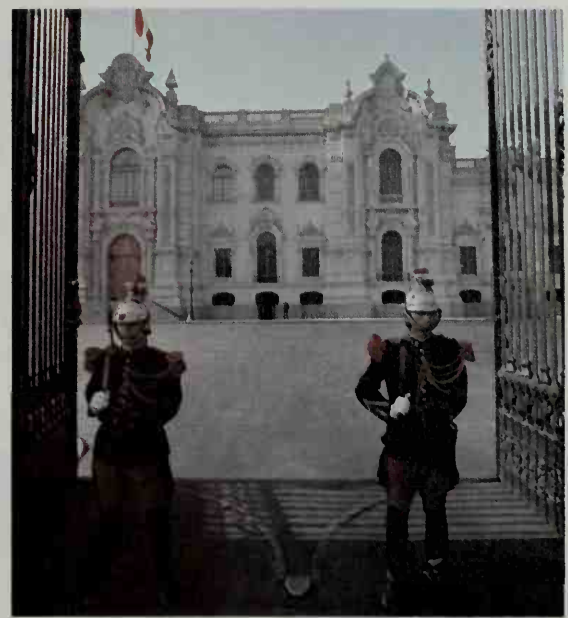
People

Population. A majority of the country's people live in ies or towns. Lima, which has a population of about million, is by far the largest, busiest, and most mod- n Peruvian city. Lima and the neighboring city of llao make up *Greater Lima.* Callao and the city of Are- ipa, each of which has more than 500,000 people, ık next to Lima in size. Two other cities in the country ve a population of more than 300,000. They are Trujil- and Chiclayo.

For more information, see the separate articles on Pe- ian cities listed in the *Related articles* at the end of s article.

Ancestry. After the Spanish conquest of Peru in the 00's, some Spaniards and Indians married. Their de- ndants are called *mestizos.* Today, it is estimated that roximately 43 percent of all Peruvians are mestizos. proximately 46 percent of the country's people are In- ns. People of unmixed white ancestry make up about percent of the country's population. Most of these ople are of Spanish ancestry. Peru also has a small mber of blacks and people of Asian descent. These ups make up less than 1 percent of the country's pulation.

Languages. Spanish became Peru's official language n after the Spanish conquest and remained the only



Claus Meyer, Black Star

Government Palace in Lima houses the office of Peru's president. The building was erected in 1938 on the site of a palace built by the Spanish conqueror Francisco Pizarro in the 1500's.



Peru's state flag, used by the government, was adopted in 1825. The unofficial national flag has no shield and wreath.

Coat of arms. The symbols on the shield represent Peru's abundant animal, plant, and mineral resources.



WORLD BOOK map

Peru lies in western South America along the South Pacific Ocean. It ranks as the continent's third largest country.



Cities and towns

Name	Population	Map key
Abancay	46,997	E
Andahuaylas	26,960	E
Arequipa	619,156	F
Ayacucho	105,918	E
Ayaviri	23,936	E
Azángaro	27,929	E
Barranca	47,271	D
Cajabamba	26,591	C
Cajamarca	92,447	C
Callao	639,729	D
Camaná	14,446	F
Catacaos	54,774	B
Celendin	21,266	C
Cerro de Pasco	62,749	D
Chachapoyas	15,785	C
Challabamba*	8,900	E
Chancay	33,689	D
Chepén	40,465	C
Chiclayo	411,536	C
Chimbote	286,685	C
Chincha Alta	50,554	E
Chocope	30,590	C
Chota	45,303	C
Chulucanas	75,844	B
Cusco	255,568	E
Ferreñafe	29,805	C
Huacho	50,192	D
Huamachuco	37,819	C
Huancané	27,959	E
Huancavelica	31,068	E
Huancayo	258,209	D
Huánuco	118,814	D
Huaral	70,668	D
Huaraz	66,888	D
Ica	161,406	E
Ilabaya	8,061	F
Ilave	49,012	F
Ilo	45,515	F
Imperial	31,196	E
Iquitos	274,759	B
Jaén	68,825	B
Jauja	19,905	D
Juliaca	155,177	E
Junín	17,311	D
Lagunas	12,164	B
Lambayeque	46,482	C
La Oroya	30,922	D
La Unión	28,274	D
Lima	5,706,127	D
Mollendo	26,122	F
Moquegua	38,837	F
Motupe	21,379	C
Moyobamba	24,800	C
Nazca	23,941	E
Paiján	19,536	C
Paita	42,779	B
Paramonga*	27,358	D
Pativilca	13,902	D
Pimentel*	19,141	C
Pisco	76,636	E
Piura	277,964	B
Pucallpa	172,286	C
Puerto Maldanado	31,249	E
Puno	91,877	F
Requena	21,078	B
San Pedro de Lloc*	15,645	C
San Vicente de Canete	33,121	E
Saña	41,463	C
Sullana	122,590	B
Tacna	174,336	F
Talara	85,020	B
Tarapoto	56,760	C
Tarma	57,056	D
Trujillo	509,312	C
Tumbes	74,085	B
Yanahuara	17,776	F

Peru map index

Departments*

Name	Population	Area In sq. mi.	Area In km²	Map key
Amazonas	369,025	15,945	41,297	B 2
Ancash	1,013,931	14,019	36,308	D 2
Apurimac	404,688	7,975	20,655	E 4
Arequipa	982,099	24,528	63,528	F 4
Ayacucho	517,270	17,569	45,503	E 3
Cajamarca	1,327,579	13,675	35,418	C 2
Callau (Constitutional Province)	682,195	29	74	D 2
Cusco	1,092,823	32,487	84,141	E 4
Huancavelica	410,104	8,831	22,871	E 3
Huánuco	707,312	13,635	35,315	D 3
Ica	597,679	8,205	21,251	E 3
Junin	1,119,600	12,492	32,354	D 3
La Libertad	1,341,640	8,973	23,241	C 2
Lambayeque	989,215	6,404	16,586	C 1
Lima	6,803,015	13,087	33,895	D 3
Loreto	777,186	131,919	341,669	B 3
Madre de Dios	71,598	30,272	78,403	D 4
Moquegua	135,506	6,245	16,175	F 4
Pasco	242,925	8,438	21,854	D 3
Piura	1,448,971	12,767	33,067	B 1
Puno	1,129,333	27,947	72,382	F 5
San Martin	607,480	20,488	53,064	C 3
Tacna	238,655	5,702	14,767	F 4
Tumbes	168,752	1,827	4,732	B 1
Ucayali	353,120	52,768	136,667	C 3

*Department names and names of cities and towns marked with an asterisk do not appear on map; key shows general location.
Sources: 1995 official estimates for departments; 1993 census for cities and towns.

fficial language for several hundred years. In 1975, the eruvian government made Quechua, the language of ıe Inca, an official language along with Spanish.

About 75 to 80 per cent of all people in Peru speak panish. The rest speak only an Indian language. uechua is by far the most common Indian tongue. bout 2 million Indians who live in the highland reion—that is, the highest parts of the Peruvian Andes—peak only Quechua. A much smaller number of highnd Indians speak Aymara, the language of a tribe onquered by the Inca in the 1400's. In the rain forests nd jungles of eastern Peru—a region called the *selva*—cattered groups of Indians speak a variety of other trib- languages. Many Peruvians speak both Spanish and n Indian language.

Ways of life. Peru's Spanish conquerors established a rict class system that was based on ancestry. A small pper class, made up of whites, controlled a huge lower ass, made up of Indians. As the number of mestizos rew, most of them also became part of the lower class. his class system lasted until about 1900, when a small iddle class of whites and mestizos began to develop.

Peru's middle class grew steadily during the 1900's. oday, it includes office workers and managers, profesonal people, owners of small businesses, and military ficers. But the great majority of Peruvians— that is, alost all Indians and most mestizos—still belong to the wer class. Peru's small upper class still consists almost ntirely of whites.

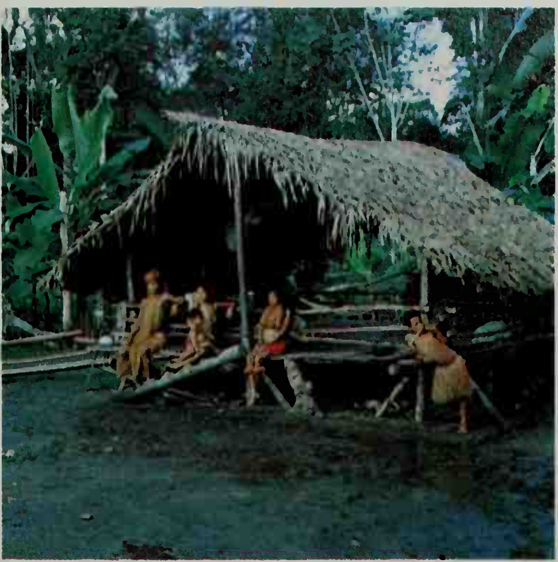
Whites. About half of Peru's whites belong to the uper class, and about half to the middle class. A few Peruan whites belong to the lower class. The whites speak panish and dress much as people do in other Western ountries.

Family ties are important in Peruvian society. But they e especially important among upper-class white fami-s, who have traditionally controlled much of Peru's ealth. These families seldom mix with people outside eir class, and in most cases their children marry into her upper-class families. Most of the families live in shionable sections of Lima and other large cities.

Mestizos, like whites, speak Spanish and wear Western-style clothing. They have always had closer ties with e white community than Indians have had. For exame, white owners of mines and plantations traditionally red mestizos to supervise Indian workers. The growth the middle class has given mestizos other opportuni-s for advancement. Today, many middle-class mesti-s attend college and become leaders in government, dustry, the armed forces, and the professions. A few estizos have even acquired enough wealth and social anding to be accepted into the upper class. But the ajority remain in the lower class.

Indians. Most of Peru's Indians live in the highlands d on the coast. A much smaller number live in the sel- Nearly all the Indians are poor, and most of them lack ormal education.

The highland Indians live at elevations up to 15,000 et (4,570 meters). The Himalaya—the great mountain stem of southern Asia—is the only other place in the orld where people live at such high altitudes. Almost highland Indians live by farming. Most of the young ople wear Western-style clothing. However, many of e older Indians wear traditional garments of handwo-



© Walter R. Aguiar

An Indian family in northeastern Peru's hot, humid rain forest needs only a thatched roof for shelter. More Indians live in Peru than in any other country in South America.

ven cloth. See **Clothing** (Traditional costumes).

The Indians of the selva belong to about 40 tribes. They live in scattered tribal villages, wear little clothing, and hunt and fish for most of their food.

Over the years, many Indians have moved from the highlands and selva to work on coastal plantations. Numerous other Indians have moved to the cities. But many of them have been handicapped by their lack of schooling and inability to speak Spanish.

Housing. Most rural families in Peru build their own houses. The typical house has one room. In the highlands, most houses have walls of adobe and a roof of grass thatch or handmade tile. Most homes in the selva have walls built of twigs or bamboo poles and a roof of grass or palm thatch.

Many kinds of housing can be found in Peru's large cities. In upper- and middle-class neighborhoods, the people live in comfortable single-family homes with enclosed patios. The largest cities also have high-rise apartments and modern public housing. But much urban housing in Peru is extremely poor.

Some lower-class families in Lima and other large cities live in crowded, unsanitary slums. But since the 1950's, thousands of families have left the slums and started *squatter* communities on public land on the edge of the cities. Today, more than a million Peruvians live in such communities.

Most squatters first build their home of cardboard, old metal, and other scrap. But because squatters do not pay rent, many families save enough money in time to build a permanent house of adobe or concrete block. To encourage these efforts, the government has named the squatter communities *pueblos jóvenes* (young towns) and supplied many with running water and a sewerage system.

Food. Most upper- and middle-class families in Peru eat a varied diet of meat, fish, poultry, vegetables, and



Jacques Jangoux

A modern section of Lima, with its expressway and high-rise apartment buildings, resembles the newer sections of large cities throughout the world. Lima is Peru's largest city by far.



Jacques Jangoux

Collecting the family water supply is an everyday chore in many poor sections of Lima. These Indians live in an improved slum area called a *pueblo joven* (young town).



Victor Englebert, Black Star

Public religious celebrations, such as this Holy Week procession in Ayacucho, attract great crowds of worshipers. Almost all Peruvians belong to the Roman Catholic Church.

cereal products. They highly season many main dishes with onions and hot peppers. Rice, potatoes, and bread accompany most main meals.

The majority of lower-class families in Peru, especially most highland Indians, have a poor and monotonous diet. The diet of the highland Indians consists largely of potatoes, beans, corn, squash, and soups made of barley or wheat. Many highland Indians chew the leaves of the coca plant. Coca leaves contain the drug cocaine, which relieves feelings of hunger (see **Coca**). The Indians of the selva have a somewhat more varied diet. These Indians raise only a small number of crops, such as corn and *cassava,* a starchy root. However, the jungle provides the Indians of the selva with many varieties of fishes and small game and several types of fruits and nuts.

Recreation. Music and dancing are extremely popular throughout Peru. Radio stations play everything from traditional Peruvian music to the latest hit tunes from the United States. Traditional Indian music is performed on drums, flutes, rattles, and a kind of small harp. Mestizo music also uses these instruments plus such others as guitars, fiddles, and horns. Mestizo bands attract large crowds in cafes and dance halls throughout Peru. Movies are also a popular form of recreation in Peru.

Soccer, which Latin Americans call *fútbol,* ranks as the most popular sport in Peru. The country's national soccer teams play against teams from other countries in Lima's 70,000-seat National Stadium. Many Peruvians also enjoy basketball, volleyball, and bullfights.

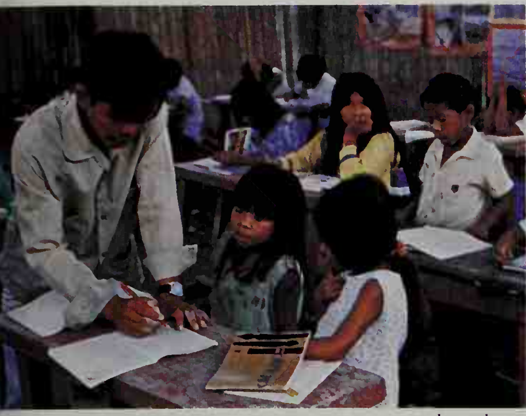
Almost every city and town in Peru holds an annual festival, called a *feria,* to honor its patron saint. Ferias include colorful religious processions, feasting, dancing, and games. Peru celebrates the anniversary of its independence on July 28.

Education. Most Peruvians 15 years of age or older can read and write. The great majority of those who cannot read or write live in rural areas, and most are Indians. Most educated Peruvians live in the cities, which have by far the greatest number of schools. For Peru's literacy rate see **Literacy** (table: Literacy rates for selected countries).

Peruvian law requires all children between the ages of 6 and 12 to attend school. But many rural children cannot meet this requirement because of a shortage of schools and teachers. Most elementary and high school students attend free public schools. Nearly all students from middle- and upper-class families go to private schools, which charge a tuition fee. Peru has about 30 universities, including the famous University of San Marcos in Lima. Founded in 1551, it ranks as the oldest institution of higher learning in South America (see **San Marcos, University of**).

Religion. About 95 percent of all the people of Peru are Roman Catholics. However, relatively few people attend church regularly. Some Indian Catholics still worship Inca gods. The Peruvian government grants freedom of worship to all religious groups, but it officially favors the Roman Catholic religion. For example, the Catholic religion is taught in public schools throughout the country. Other religious groups in Peru include Protestants, Jews, and Buddhists.

The arts. Peru's artistic traditions date back nearly 3,000 years, when the country's Indians began to create



Jacques Jangoux

village school, one of many opened in Peru since the early 60's, helps rural Indian children learn to read and write. In the st, few of the country's Indians received any schooling.

autiful sculpture, pottery, jewelry, and textiles. Peru's dians still practice these arts and crafts. The Inca were pert architects. Examples of their architectural skill can seen in many parts of Peru.

The Spanish colonists constructed many richly deco-ted churches and public buildings in Peru. Earth-akes have destroyed many of these structures. But me have been rebuilt. For examples of the Spanish co-nial style of architecture, see **Lima** (picture: The Plaza Armas).

The first great Peruvian writer was Ricardo Palma, o wrote during the last half of the 1800's and the early 00's. Palma won fame throughout the world for his ries about life in colonial Peru. Later in the 1900's, ny talented Peruvian authors championed the cause the Indian. These writers include the political writer é Carlos Mariátegui, the poet César Vallejo, and the velists Ciro Alegría and José María Arguedas. During 1960's and 1970's, Mario Vargas Llosa became famous for his novels about the relations between Peru's social classes.

Land regions

Peru has three main land regions. They are, from west to east: (1) the coast, along the Pacific Ocean; (2) the highlands, the highest parts of the Peruvian Andes; and (3) the selva, a region of forests and jungles. Earthquakes occur frequently in Peru. Most of them center in the highlands, and their effects extend to the coast. A terrible earthquake in 1970 killed more than 66,000 people, chiefly in the northern highlands.

The coast consists of a long, narrow strip of land between the Pacific Ocean and the highlands. The region includes the western foothills of the Peruvian Andes. Most of Peru's large cities, commercial farms, and factories lie along the coast. Nearly all the coast is dry, rugged desert. But about 50 rivers, which flow from the mountains, cross the region. The rivers provide irrigation water for coastal farms as well as drinking water for the towns and cities.

The highlands consist of all areas of the Andes Mountains above 6,500 feet (1,980 meters). Narrow valleys and plateaus make up much of the region. The tallest highland peaks have snow the year around, and some have permanent glaciers. The highest peak is 22,205-foot (6,768-meter) Huascarán, an extinct volcano. Few trees grow in the highlands. But many of the valleys have a thick cover of grass. The Indians use these valleys for grazing herds of livestock, especially llamas and sheep. See **Andes Mountains**.

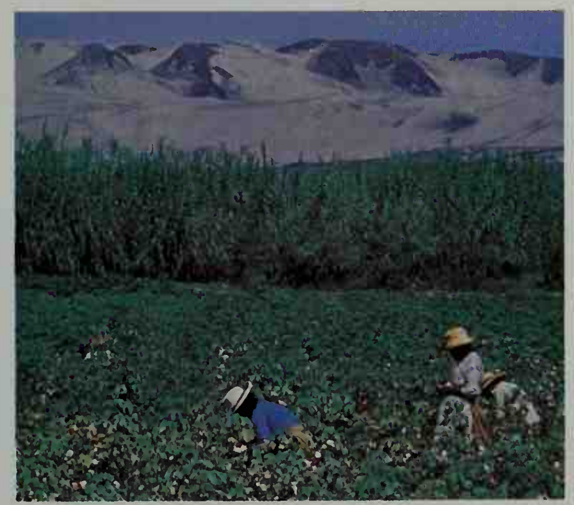
Lake Titicaca, in the southern highlands, is Peru's largest lake. Part of the lake lies in Bolivia. The Peruvian part covers 1,914 square miles (4,957 square kilometers). Lake Titicaca lies 12,507 feet (3,812 meters) above sea level. It is the highest navigable lake in the world. See **Lake Titicaca**.

The selva has two subregions—the high selva and the low selva. The *high selva* consists of the eastern foothills of the Andes. Unlike the dry western foothills,



Robert Bunge, Black Star

C**orful handwoven goods,** like these displayed for sale be-s a road near Cusco, have been produced in Peru for nearly 3 0 years. Peru's craftworkers are famous for their artistry.



Jane Vincent, Black Star

Peru's coastal desert consists largely of barren land like the sand-covered hills in the background. But with irrigation, the land produces cotton, *foreground,* and other crops.

the eastern foothills are covered with green forests. The *low selva* consists of low, flat plains east of the high selva. Thick rain forests and jungles cover almost all the low selva. The Amazon River, South America's longest river, flows through this region (see **Amazon River**).

Climate

Peru lies entirely within the tropics. But the Peru Current, an unusually cold ocean current, makes the coast cooler than is normal for a tropical region (see **Peru Current**). Coastal temperatures average 73 °F (23 °C) from November through April and 61 °F (16 °C) from May through October. Because of the high altitudes, temperatures in the highlands range even lower than do coastal temperatures. At the highest elevations, the temperature never rises above freezing. But at elevations below 10,000 feet (3,000 meters), frosts never occur. Most of the selva has high temperatures throughout the year. In many places, the temperature averages nearly 80 °F (27 °C).

The amount of rain, snow, and other forms of *precipitation* increases greatly from the coast to the selva. Because the air along the coast is cool, it cannot hold much moisture. In addition, air from the wet east loses its moisture in the Andes before it reaches the coast. As a result, the coast seldom receives more than 2 inches (5 centimeters) of rainfall a year. Much of the western highlands has less than 10 inches (25 centimeters) of annual precipitation.

The eastern highlands and the selva have a wet season from November through April and a dry season from May through October. Much of the eastern highlands receives more than 40 inches (100 centimeters) of precipitation a year. Most of the selva has at least 80 inches (200 centimeters) of precipitation annually, and some parts of the high selva receive more than twice that amount.

Economy

In the past, upper-class families controlled most of Peru's resources and industries. In 1968, a military government took power. The military leaders took over some businesses and gave part ownership of some farms and factories to the employees. In 1980, a civilian government began increasing private ownership. Government leaders hoped that increased private enterprise might relieve some of Peru's economic problems, including rapid inflation and high unemployment. At



st, the government was slow to carry out its policies. the 1990's, the government took a more aggressive proach to increasing private enterprise, and inflation is brought under control. But high unemployment and me other economic problems continued.

Agriculture. Farming is the chief occupation in Peru. any farm families own a small plot of land on which ey produce barely enough to feed themselves. Others ork on large *cooperative* farms. On such farms, the orkers own and operate the farm as a group.

Coffee, cotton, and sugar cane are Peru's chief export ops. Highland farms produce most of the coffee. Irrited farms along the coast grow most of the cotton d sugar cane. Most other crops are grown mainly to eet the country's own food needs. These crops include nanas, beans, corn, potatoes, and rice.

Mining. Peru ranks among the world's leading procers of copper, silver, and zinc. All these minerals are ned chiefly in the highlands. The country also proces much iron ore, lead, and petroleum. The richest n mines lie on the far south coast. The north coast d the selva have the largest petroleum deposits. The ghlands have important gold deposits.

About 40 small islands off the Peruvian coast have ge deposits of *guano* (bird droppings), which makes a od fertilizer. A government company mines the ano and sells it to mainland farmers. See **Guano.**

Fishing. Peru ranks among the leading counes. Each year, the country's fishing fleets take large antities of anchovies (sometimes called *anchovettas*), dines, tuna, and other ocean fishes. Sardines make by far the largest catch. Fish meal made from dried uvian sardines and anchovies is sold throughout the rld for use in livestock feed.

To avoid overfishing and ensure a profitable catch by uvian vessels, Peru claims authority over waters up 200 nautical miles (370 kilometers) off its coast. The vernment charges foreign vessels a high fee to fish in se waters and seizes vessels that refuse payment. s practice has caused a number of clashes between . fishing vessels and Peruvian authorities.

Manufacturing. Much manufacturing in Peru is done a small scale by individual craftworkers. But some nufacturing plants, chiefly along the coast, have many rkers and use mass-production methods. Many of se plants process raw materials for export. The chief cessed goods include fish meal, petroleum prods, refined metals, and sugar. Other large factories duce chemicals, furniture, paper products, proced foods, steel, and cotton and woolen textiles.

Trade. Peru's leading exports include fish meal, peeum, and minerals, especially copper and silver. The ntry also exports coffee, cotton, and sugar. Imports ude machinery, motor vehicles, other manufactured ds, dairy products, meat, and wheat.

he United States has long been Peru's chief trading tner. But since the 1950's, Peru has increased its trade outh America and with Europe and Japan.

Transportation. Travel across Peru is hindered by rugged Andes. Most of the country's roads are uned. Peru has an average of about 1 automobile for ry 50 people. The Peruvian section of the Pan Ameri Highway is the longest paved road. It extends 1,710 s (2,752 kilometers) along the coast (see **Pan American Highway**). A branch of the highway extends southeast from the coast into Bolivia. A number of side roads run east from the highway into the highlands, and some continue into the selva. But most travel in the selva is by river. Llamas often serve as pack animals in the highlands. Peru has two airlines. They connect Lima with all parts of Peru and with other Latin-American countries.

The Central Railway extends from the Greater Lima area to mines and ore refineries that are located high in the Andes. The railway climbs to 15,844 feet (4,829 meters) above sea level, higher than any other standard-gauge railroad in the world. The Southern Railway connects the Peruvian port of Mollendo with Arequipa and other cities and towns in the southern highlands. For additional information about transportation in Peru, see **Andes Mountains.**

Peru has few good natural harbors. But some harbors have been developed into important seaports. Callao ranks as the chief international port.



Jacques Jangoux

An open-pit mine high in the Andes produces copper, lead, and zinc. Peru has enormous mineral deposits, and mining plays a major role in the country's economy.



Jacques Jangoux

Workers in a fish-processing plant near Piura handle part of Peru's enormous annual catch of ocean fish, *above.* Fishing is a leading industry in Peru.

Communication. Lima has about seven daily newspapers, and most other cities have at least one. Most Peruvian newspapers are privately owned, and they represent a variety of political viewpoints.

Radio is an important means of mass communication in Peru. Most Peruvian families own a transistor radio. Programs are broadcast in both Spanish and Quechua. Peru has an average of about 1 television set for every 10 people. Many people watch television in public places. Television offers both local programs and foreign programs with Spanish sound tracks. The government operates some radio and television stations. Others are privately owned. The government owns and operates Peru's postal system.

History

Scholars believe that the first people to live in Peru were Indians who came from North America about 12,000 years ago (see **Indian, American** [Early days]). Gradually, the Indians learned to farm. They tamed the llama and began to cultivate the potato, which grew wild in the highlands. Potatoes became an important food in Peru long before they were known anywhere else in the world (see **Potato** [History]).

The Chavin Indians developed the first known civilization in Peru. The civilization reached its peak from about 800 to 400 B.C. Later, other groups, such as the Moche (or Mochica), Tiwanaku (Tiahuanaco), and Chimu, also developed civilizations in Peru. The Chimu built a large capital city called Chanchan. It was begun about A.D. 1000. Chanchan's ruins cover about 8 square miles (20 square kilometers) near present-day Trujillo.

About 1200, a people called the Inca founded a kingdom in southern Peru. The Inca were master architects and roadbuilders and accurate astronomers. They were also dedicated lawmakers and warriors. By the early 1500's, the Inca had built a great empire, and their civilization had reached its peak. The Inca rule extended north into parts of present-day Colombia and Ecuador and south as far as present-day Chile and Argentina. For detailed information, see **Inca**.

Spanish conquest and rule. In the mid-1520's, the Spanish adventurer Francisco Pizarro began to explore the west coast of South America. He had heard tales of the Inca empire and of its treasures of silver and gold.



David Brill

Chanchan, capital of the Chimu Indians, lies in ruins near Trujillo. The Chimu were part of a long series of civilizations that flourished in Peru before the Spaniards came in the 1500's.



Dana Midd

The ruins of Machu Picchu, probably once an Inca royal est stand near Cusco. The Inca, who built Peru's last great Indian c lization, were conquered by the Spaniards in the 1530's.

About 1527, Pizarro and a few followers landed near t Inca city of Tumbes on Peru's north coast. They becam the first white men to set foot in Peru.

Pizarro saw enough riches at Tumbes to convince h that the legends about the Inca were true. He returnec in 1532 with about 180 men, who were later joined by other Spanish troops. By the end of 1533, the Spanish had easily conquered most of Peru, including the fabu lous city of Cusco, the Inca capital. In 1535, Pizarro founded Lima. It became the center of the Spanish go ernment in South America. For the story of the Spanis conquest of Peru, see **Inca** (History); **Pizarro, Francisc**

Spain ruled Peru for nearly 300 years. During this time, thousands of colonists arrived from Spain to see their fortune. Soon after the conquest, the king of Spa appointed a *viceroy* (governor) to enforce Spanish law and customs. The Indians had to become Christians a take Spanish names. Whole families were forced to work on plantations and in mines.

Peru quickly became one of Spain's most profitable colonies. But from time to time, Indians and *mestizos* (people of mixed Indian and Spanish ancestry) rebelle against the harsh white rule. A widespread revolt bro out in 1780. It was led by a mestizo who called himsel Tupac Amaru, after one of the last great Inca leaders. The Spaniards captured and executed him in 1781 an crushed the uprising the following year.

The war of independence. The chief heroes of Peru's independence from Spain were José de San Martín of Argentina and Simón Bolívar of Venezuela.

hey wanted to end European rule throughout South ımerica, and Peru became one of their main targets. Aost Peruvians took little or no part in the independ-nce movement. The white upper class benefited from panish rule, and the Indians expected to gain little if eru became independent.

San Martín invaded Peru in 1820 with an army of Ar-entines and Chileans. He declared the country inde-endent in 1821, though much of it remained under panish control. Bolívar led an army of Venezuelans and :olombians into Peru in 1823. The next year, Antonio osé de Sucre, one of Bolívar's generals, defeated a ırge Spanish force at Ayacucho in south-central Peru. he remaining Spanish troops held only the city of Ca-ao. They finally surrendered in 1826. Although Peru had ecome free, Spain did not formally recognize its inde-endence until 1879.

The early republic. Peru's first constitution went into ffect in 1827. It declared Peru a democratic republic. lso in 1827, the legislature elected General José de la lar as Peru's first president. He became the first in a ng series of military officers who held the presidency uring most of the 1800's. Many of the military presi-ents seized office in armed uprisings. The most impor-nt of these presidents was General Ramón Castilla.

Castilla became one of the first mestizos to hold high ublic office in Peru. He served as president from 1845 1851 and from 1855 to 1862. Castilla developed the uano industry and opened trade with Europe and the nited States. He also ended the *tribute* (tax) that Indian orkers had to pay their employers.

The War of the Pacific cost Peru its valuable nitrate eposits. Nitrates are minerals used in making fertilizer nd explosives. The War of the Pacific began as a quar-l between Bolivia and Chile over control of certain Bo-ian nitrate deposits. As a result of the dispute, Chile vaded Bolivia in 1879, marking the start of the war. eru entered the conflict because it had agreed to aid olivia in the event of war with Chile.

Chilean troops occupied Lima in 1881 and seized eru's nitrate-rich southern provinces of Tacna, Arica, nd Tarapacá. Chile also took Bolivia's coastal and desert nds around the city of Antofagasta. The Treaty of An-on ended the war in 1883. The treaty allowed Chile to keep the captured Peruvian provinces, but Chile returned Tacna to Peru in 1929.

The growth of U.S. influence. The War of the Pacific left Peru deeply in debt. Nicolás de Piérola, who had served as president during the war, took over again as president in 1895. He and most of the presidents who followed him in office encouraged foreign investment in Peru to help develop the country's resources and so reduce its debt. The U.S. firm of W. R. Grace and Company already had sizable investments in Peru, including a textile mill and a number of sugar plantations and refineries. In 1901 and 1902, a group of U.S. businessmen formed the Cerro de Pasco Corporation to develop Peru's copper deposits. The International Petroleum Company, a branch of the Standard Oil Company (New Jersey), now part of Exxon Mobil Corporation, gained control of the oil deposits in northwestern Peru in 1921.

Peru's economy improved in the early 1900's. But it worsened under the presidency of Augusto B. Leguía in the 1920's. Leguía, president from 1908 to 1912, was re-elected in 1919. He soon set himself up as a dictator. To finance his programs, Peru borrowed large sums of money from U.S. banks. Then early in 1930, Peru felt the first effects of the worldwide depression that began in 1929. The armed forces, alarmed by Peru's rising debt, overthrew Leguía and made Colonel Luis Sánchez Cerro president in August 1930.

The rise of APRA. Peru had a number of political parties before the 1920's. But most of them favored the upper class. In 1924, Víctor Raúl Haya de la Torre founded a party called APRA, an abbreviation for Alianza Popular Revolucionaria Americana (American Popular Revolutionary Alliance). APRA called for public ownership of Peru's basic industries and demanded equal rights for all citizens, including Indians.

Haya de la Torre ran for president against Sánchez Cerro in 1931 and lost. APRA charged dishonesty in vote counting and staged violent antigovernment protests. The government then jailed or killed hundreds of APRA supporters. It also banned the party from running political candidates. But APRA continued to gain followers during the 1930's and early 1940's.

In 1945, President Manuel Prado ordered the first election since 1931 in which APRA candidates could take part. But the party did not run a presidential candidate of its own. Instead, it supported José Luis Bustamante, a respected lawyer and diplomat, who won the election. But quarrels with other political groups led APRA to further acts of violence after the election, and Bustamante outlawed the party in 1948. Later that year, military leaders overthrew Bustamante's government and named General Manuel Odría as president. For eight years, Odría worked to reduce APRA's influence. But he legalized the party before the 1956 election, the first in which Peruvian women voted. Manuel Prado, who had been president from 1939 to 1945, gained APRA's support and won the election.

In the 1950's and early 1960's, APRA lost popularity, while the Popular Action Party led by Fernando Belaúnde Terry gained support. Belaúnde was elected president in 1963 and worked to improve the Indians' living conditions and educational opportunities.

Socialistic reforms. Peru began to have financial problems in the late 1960's. Many Peruvians blamed the

ıportant dates in Peru

300-400 B.C. The civilization of the Chavin Indians, the first known civilization in Peru, reached its peak.

A.D. 1500 The empire of the Inca Indians reached its greatest size.

32-1533 Spanish troops led by Francisco Pizarro conquered Peru and made it a Spanish colony.

30 The mestizo Tupac Amaru led an unsuccessful revolt of Indians and mestizos against white rule.

21 José de San Martín declared Peru independent of Spain.

79-1883 Peru lost its nitrate-rich southern provinces to Chile in the War of the Pacific.

24 The revolutionary APRA political party was founded.

68 Military leaders took control of Peru's government and began socialistic reforms.

30 A civilian government, elected by the people, began working to increase private enterprise.

12 In April, President Alberto Fujimori suspended Peru's Constitution and dissolved the legislature.

13 Peru adopted a new constitution. It was written by a popularly elected Constituent Assembly.



AP/Wide World

A hostage rescue mission in Peru in 1997 freed 72 hostages who had been held by rebels at the Japanese ambassador's residence in Lima. President Alberto Fujimori, *in black bulletproof vest,* authorized Peruvian troops to raid the residence.

problems on the United States, whose political and business interests in the country were increasing. In August 1968, President Belaúnde reached a complicated financial agreement with the International Petroleum Company in return for the company's Peruvian oil fields. Belaúnde's opponents charged that the agreement favored the company. In October, military leaders seized the government and formed a ruling *junta* (council). The junta named one of its members, General Juan Velasco Alvarado, as Peru's president.

The new government called itself the revolutionary government. It took over most of Peru's plantations and turned many of them into cooperatives. It also seized the holdings of International Petroleum, Cerro de Pasco, and W. R. Grace. In the early 1970's, the government began an industrial reform program that gave workers partial control over some industries.

By the mid-1970's, the government faced growing criticism. Members of the armed forces filled all major political posts, and civilians demanded a greater voice in the government.

Return to civilian government. In 1980, the people elected a civilian government to replace the junta. Belaúnde was again elected Peru's president. His government took some steps to increase private enterprise. Since the 1980's, leftist groups called Shining Path and the Tupac Amaru Revolutionary Movement have sought to overthrow the government by using guerrilla tactics.

In 1985, Alan García Pérez of APRA was elected president. In 1990, Alberto Fujimori, an independent, won th office. Both men increased private enterprise and took other steps aimed at improving the economy. But economic problems and violence continued.

Recent developments. In April 1992, Fujimori suspended Peru's Constitution and dissolved the legislature. He claimed there was corruption among government officials. He accused officials of failing to pass reforms to eliminate terrorism and the drug trade. Many Peruvians backed Fujimori. Others called him a dictator. In September, Peru's National Police arrested Abimael Guzmán Reynoso, the leader of Shining Path. In October, he and 10 others were convicted of high treason fo terrorist crimes and sentenced to life in prison.

In November 1992, popular elections were held to form a Constituent Assembly. Supporters of Fujimori won a majority of the seats. The Assembly wrote a new constitution that took effect in December 1993. Fujimori and the Assembly continued to serve until new presidential and legislative elections were held in 1995. In th elections, Fujimori was reelected president, and his par ty won a majority of the seats in the Congress.

In December 1996, Tupac Amaru rebels seized the Japanese ambassador's residence in Lima and took a group, mainly diplomats and business executives, as hostages. In April 1997, Peruvian troops rescued the 72 hostages still held. All the rebels were killed in the raid.

In May 2000, Fujimori was reelected to a third term a president. Opponents accused him of vote fraud, and many opposition supporters boycotted the election or spoiled their ballots. Later that year, a bribery scandal ir volving a top Fujimori aide led to Fujimori's resignation as Peru's president. But the Peruvian National Assembly refused to accept his resignation and instead declared him "morally unfit" for the presidency and removed hin from office. In June 2001, Alejandro Toledo was electec president of Peru. Toledo had run against Fujimori in th previous year's election. David J. Robinson

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C. The armed forces

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Questions

ho developed the first known civilization in Peru?
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hat was the War of the Pacific? How did it affect Peru?
hat is an important means of mass communication in Peru?
hat role did Francisco Pizarro play in Peru's history?
w does life differ among Peru's population groups?
hat are *pueblos jóvenes?*

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ru Current, *puh ROO,* is a cold, broad, shallow rrent in the Pacific Ocean. It flows slowly north along west coast of South America. Along the coast of u, the temperature of its waters is 15 °F (8 °C) colder n normal for the surface of the Pacific in that latitude. st scientists believe the current's cold waters are due marily to winds that blow the warm surface waters ay from the coast. This causes cooler waters from be- v to surface. This current is also called *Humboldt Cur- nt* (see **Humboldt, Baron von**). Mark A. Cane

rutz, *PEHR uhts,* **Max Ferdinand** (1914-2002), a tish molecular biologist, shared the Nobel Prize in emistry in 1962 with John C. Kendrew. Through X-ray hniques, they traced the structure of hemoglobin and oglobin, two proteins found in blood and muscles. utz spent 22 years on his research, concentrating on noglobin. Born on May 19, 1914, in Vienna, Austria, fled to England in 1936 to escape Nazism. His essays re collected in *Is Science Necessary?* (1989). He died Feb. 6, 2002. Trevor H. Levere

scadores, *PEHS kuh DOHR eez* (pop. 100,288), are a up of 63 islands that cover a total area of 49 square es (127 square kilometers) in the Taiwan Strait be- en Taiwan and China. The Taiwanese name for the nds is P'eng-hu. For location, see **Taiwan** (map).

Chinese expedition discovered the islands in 1367. islands were named *Pescadores* (fishermen's is- ds) in the 1500's by Portuguese sailors. They were oc- ied by the Dutch from 1622 to 1624, when China re- ned them. During the late 1600's, the Pescadores ame a dependency of Taiwan, and they have be- ged to Taiwan since. Industries on the islands include fishing and fish processing. Parris H. Chang

Peseta, *puh SAY tuh,* was the unit of money in Spain and the Spanish dependencies, and of Andorra. It consisted of 100 centimos. The early silver one-peseta piece





WORLD BOOK photos by James Simek

The peseta was the monetary unit of Spain.

showed the king's head and the Spanish coat of arms. Later coins showed such objects as a sheaf of wheat or a galleon. Peseta notes and coins were replaced by those of a new European Union currency, the euro, in 2002.

Burton H. Hobson

Peshkov, Alexey Maximovich. See Gorki, Maxim.

Peso, *PAY soh,* was the name of the old Spanish dollar. It was called the *peso de oro* when it was made of gold, and the *peso de plata* when made of silver.

The peso was replaced by the peseta as the standard of value in Spain, and the peseta was later replaced by the euro. But the peso is still an important money unit in





WORLD BOOK photos

The new peso is the monetary unit of Mexico.

Spanish American countries, though its value varies in each country. It is the monetary unit of Argentina, Chile, Colombia, Cuba, the Dominican Republic, the Philippines, and Uruguay. The new peso is the monetary unit of Mexico. The name *peso* comes from the Latin word *pensum,* meaning *weight.* Burton H. Hobson

See also **Piece of eight.**

Pest control is a term that identifies various methods used to reduce or eliminate pests. Any living thing that kills plants or stunts their growth, carries disease, or is harmful in other ways may be considered a pest. Pests include insects, weeds, mammals, *pathogens* (disease-causing microorganisms), and *nematodes* (microscopic roundworms). The two major pest control methods are (1) *pesticides,* chemicals used to kill pests, and (2) natural pest control, which uses various preventive measures instead of chemicals. Many pest control experts favor a diverse approach called *integrated pest management,*

which combines pesticides and natural control methods.

Pesticides are classified according to the pests they control. The four main types of pesticides are (1) herbicides, (2) fungicides, (3) rodenticides, and (4) insecticides.

Herbicides eliminate plants that grow where they are not wanted. Farmers use them to reduce weeds among their crops. Herbicides also control weeds in such public areas as parks and ponds. People use herbicides in their yards to get rid of crab grass, dandelions, and other weeds

Fungicides. Certain fungi cause disease and may infect both plants and animals, including human beings. Fungicides control plant diseases that infect food crops. Wood used for building houses is often treated with fungicides to prevent dry rot.

Rodenticides are used to control rats and other rodents that destroy stored food. Rats also carry bacteria that cause such diseases as rabies and typhus.

Insecticides. Farmers use insecticides to protect their crops from insect damage. In urban areas, public health officials use them to fight mosquitoes and other insects that carry germs. People use insecticides indoors to control such pests as ants and cockroaches.

Effects of pesticide use. Pests may develop resistance to pesticides so that higher dosages must be used over time. Eventually pesticides can become ineffective, so there is a constant need to create new pesticides. Over 600 species of plant and animal pests have been found to be resistant to at least one type of pesticide.

Pesticides are poisons that can have unintended effects on people and on the environment. Wind or rain can carry herbicides from weeds to desirable plant species, such as trees and flowers. Insecticides kill beneficial insects, such as honey bees and ladybugs. Health officials worry about small amounts of pesticides that remain on food. Most people and many animals have pesticide traces in their fat tissue.

People used chemical pesticides for many years without realizing their harmful effects on humans and the environment. In 1962, American marine biologist Rachel Carson wrote the book *Silent Spring* to call public attention to pesticide dangers. The book helped to reduce pesticide use throughout the world.

In the United States, the Federal Insecticide, Fungicide, and Rodenticide Act, originally enacted in 1947, limits pesticide use on food. It requires users of the most dangerous pesticides—called *restricted use pesticides*—to have a special license to use them. The federal government may order people who use pesticides improperly to pay large fines.

Natural pest control helps avoid pest attacks without the use of chemical pesticides. For example, destroying plants after harvest will deny pests food and shelter. *Crop rotation* (planting a different crop each year) prevents excess numbers of any one pest from building up. Pest managers also use biological control methods, such as encouraging a pest's natural enemies.

Integrated pest management, also known as IPM, has largely replaced reliance on pesticides as an approach to pest control. IPM combines a limited use of chemical pesticides with natural control methods. Pest managers track levels of pest infestation and apply pesticides only when they will produce the greatest benefits. For example, if a pest left untreated would produce $5 worth of damage and applying a pesticide would cost $100, then the best decision is to leave the pest untreat ed. Pest managers use natural control measures until t cost of not controlling a pest exceeds the cost of apply ing a pesticide. H. Michael Linker

Related articles in *World Book* include:

Carson, Rachel
DDT
Fungicide
Insecticide
Pheromone
Plant (Plant enemies)
Weed

Additional resources

Flint, Mary L., and Driestadt, S. H. *Natural Enemies Handbook: The Illustrated Guide to Biological Pest Control.* Univ. of Cali Pr., 1998. Information on integrated pest management.

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Pestalozzi, *pehs tuh LAHT see,* **Johann Heinrich** (1746-1827), was a Swiss educator who became a pioneer of modern education. Many of his ideas were ne and startling for his time but have been absorbed into present-day educational practices and theory.

Pestalozzi was one of the first educators to base his ideas on child psychology. He adjusted his teaching methods to children's stages of development. In all his theories, he stressed the dignity and worth of each pe son. He believed the purpose of education is to ensur the full development of each student's unique abilities He thought education should aim for the intellectual, physical, and moral development of the individual.

Pestalozzi's teaching methods were revolutionary fo his time. For example, he felt children could learn best in an atmosphere of love and freedom rather than by harsh discipline. Therefore, a child's education should begin in a warm and loving family. He also taught children to use their senses and to learn from doing rathe than simply memorizing facts.

Many of Pestalozzi's educational theories were base on what he called *Anschauung,* a German word that means *perception* or *observation.* He felt that observation of objects, other people, and moral situations is t basis of all true knowledge. He believed children progress from an understanding of simple objects to a comprehension of difficult philosophical concepts.

Pestalozzi left a lasting impact on education. His em phasis on the importance of understanding children helped establish the need for careful teacher training.

Pestalozzi was born Jan. 12, 1746, in Zurich, Switzerland. He attended the University of Zurich, where he f studied for the ministry and later changed to law. He abandoned both careers and took up farming. In 1774 he turned his farm into a school for poor children, where he developed many of his educational ideas. In 1798, the Swiss government appointed Pestalozzi to head an orphanage at Stans, near Lucerne. During the early 1800's, Pestalozzi founded schools in Burgdorf a Yverdon. His work at these schools brought him inter tional recognition. Educators from Europe and North America came to study his methods. Many of them formed teacher institutes based on Pestalozzi's ideas. major theories are presented in his books *Leonard an Gertrude* (1781-1787) and *How Gertrude Teaches Her Children* (1801). Douglas Sloan

Pesticide. See Pest control.



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A pet depends on its owner for food, shelter, and grooming. Many children learn responsibility by caring for pets. In this photograph, a girl and her father bathe their Irish setter.

'et. Animals have been kept as pets by people in all arts of the world for thousands of years. The most ommon pets are dogs, cats, parakeets, canaries, and sh. But many people keep unusual pets, such as rac-oons, skunks, alligators, and monkeys. Many Japanese hildren tame mice and teach them to dance to music. xplorers in Antarctica have treated penguins as pets. he people of India make pets of mongooses. Cormo-ants are common pets in China.

Pets can make interesting, playful companions. Peo-le enjoy teaching them to do tricks and to obey com-nands. Pet owners often consider their pet to be a nember of the family. Many children spend more time ith their pets than they do with adults. By caring for ets, children learn responsibility. They must see that ieir pets have food, exercise, and a proper place to live. lost children like talking to and even telling secrets to ieir pets.

Pets also can contribute to a person's general well-eing. Research shows that being with animals can im-rove a person's morale, and that the presence of pets an lower one's blood pressure. Many people look and el more relaxed while with their pet. Many people liv-g alone in nursing homes or in hospitals enjoy com-unity programs that bring pets to visit. Today, many ich institutions keep cats, birds, fish, and other pets for eir residents.

In addition to providing companionship, many pets so serve other useful purposes. Dogs hunt, guard roperty, herd cattle and sheep, and assist blind people. ats often keep homes and barns free from mice and ts. Pets such as frogs and toads help keep gardens ee from certain kinds of insects. Canaries fill the air ith happy, pleasing songs.

Kinds of pets

Pets for the home. The kind of home you live in, and here you live have much to do with the kind of pet you ioose. Dogs, cats, birds, and fish are easy to care for in most any kind of home.

Before choosing a dog as a pet, you should consider e size of both your home and the dog. For example, a llie needs a large home with a big yard for exercise. If you live in an apartment, you should be sure pets are al-lowed. Then choose a small dog, such as a cocker span-iel. A small dog can get most of its exercise by playing around the house, and needs only short walks outside for fresh air.

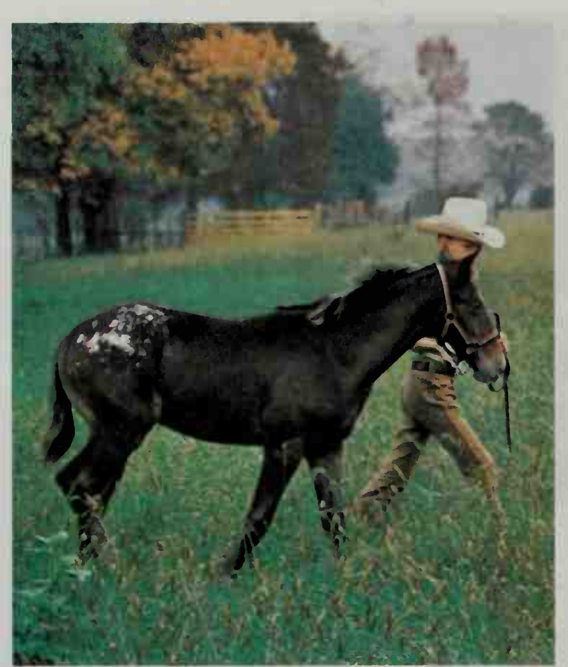
Cats do not depend on their owners as much as dogs do. Many people prefer them for this reason. They are quieter and gentler than dogs. But they, too, need out-door exercise. On pleasant days, a cat can run around in a yard. A cat should always be brought inside at night.

Various kinds of birds make fine pets for a small home or apartment. They live in cages that take little



Jim Collins

An aquarium of pet fish can be kept in almost any home, even a small apartment. Fish, unlike most kinds of pets, do not have to be fed every day.



Walter Chandoha

Most farm children keep a variety of animals as pets. Some farm pets, such as horses, are also used by the farm family in their work.

space, and their singing, beauty, and antics will please you by the hour. Canaries sing songs, and their peppy, cheerful ways make them pleasing pets. The parakeet is one of the most popular birds. It can learn to talk and is a great clown. A parakeet can be trained to walk a tightrope, go through a tunnel, push and pull toys, and ride in toy cars or trains.

Fish have one advantage over most other pets. They can be left alone for a day or two without food. Most fish need food only a few times a week. You can make what is often called a *balanced aquarium* by growing plants in the fish tank. Plants supply some oxygen for the fish. The water need not be changed, but sometimes more water must be added to replace that which evaporates. Some kinds of tropical fish need extra care, such as controlled temperature, special foods, or oxygen bubbled through the water (see **Aquarium, Home**).

Other small animals, including white mice, guinea pigs, and hamsters, may be kept as pets in a home.

Farm pets. Farm children usually have many kinds of pets. Almost every farm has one or more dogs, and cats to keep down the mice. The children also play with and care for the baby animals that live on the farm. They may make pets of lambs, rabbits, and even pigs. Baby chickens and ducklings often follow children around the yard, hoping for food. The children may have a pony or a gentle horse to ride. Many farm boys and girls raise calves to show at county fairs. They brush their calves to keep them clean and sleek. They also make sure that the animals have clean straw for their beds.

Pets in school. Many school classes keep animals in the classroom as pets. Boys and girls learn how these animals eat, sleep, play, and take care of their young. They build houses or cages for their pets, and feed and care for them. Rabbits, guinea pigs, hamsters, mice, rats, fish, frogs, toads, and snakes are among the favorite schoolroom pets. Sometimes classes build glass ant houses or beehives. Then they can watch the activities of a whole group of insects.

Choosing a pet

Before buying a pet, learn as much as possible about all kinds of pets. Choose an animal that can live comfortably in the amount of space you have for it. Find out whether the pet needs outdoor exercise and, if so, how often. Will the pet need care during the day and will someone be at home to take care of it? How does the animal behave? Does it act differently with strangers? Is it playful with young children, or does it become irritable? What foods does it eat, and how much do these foods cost?

The only way to be certain what a pet will look like when it grows up, and how it will behave as an adult, is to buy a *purebred* animal. This is an animal whose parents were both of the same breed. But *mongrels,* or animals of mixed breeds, also make fine pets. Buy your pet from someone who has raised that kind of animal for a long time, or from a well-kept pet shop. Then you will know the animal has had good care, proper food, and all necessary vaccinations against disease.

Training your pet

Before you start to train any kind of pet, you must have its respect and affection. You must always treat



Jim Collins

White mice make excellent classroom pets. By studying such pets, students gain direct knowledge of animal behavior. They also learn how to take care of the pets.

: fairly. For example, the first time your dog jumps up at ou, make it get down. If you let your dog jump on you vhen its paws are dry and clean, it probably will do so vhen they are wet and dirty. The dog does not know vhen it should not jump on you, and so you should not ɜt it form the habit. Say firmly, "No, no" or, "Get down" s you put your pet down. Do this every time, until the og learns not to jump on you.

Always speak gently to your pet, and try not to make uick, unfamiliar movements. This does not mean you annot scold your pet. If the animal misbehaves, scold it t once. Use simple words, such as *no, no* or *naughty,* nd say them so that the pet knows you are unhappy vith it. Do not shout or speak angrily. The pet will not ɜmember for long why it is being scolded, so make the colding short. Of course, this kind of training is useless or such pets as fish and turtles.

House training. You should make preparations for ouse training a puppy or kitten even before bringing it ome. For example, you can make a den-bed for a uppy by building a stout box with a lid and air holes. he puppy will be discouraged from using the box as a oilet if you make it only large enough for the pet to lie own and gnaw a bone. A dog instinctively wants to ɜep its bed clean. The animal cannot get out of the box y itself, and so it will make noise to let you know its ɜed.

Bring the puppy home in the morning, so it can take ɜveral naps in the box that day. Meanwhile, select a ace outdoors that you want your pet to use as a toilet. fter you clean up the puppy's first body wastes, take em to the outdoor place and bring the animal there. ne smell of its wastes will let the puppy know where to lieve itself. When your puppy uses the right place, aise the pet and take it back into the house. The puppy ould spend the night in the box and should not be ven food or water after 6 p.m.

A puppy needs to be taken out several times a day: (1) hen it awakens in the morning, (2) after naps, (3) after eding, and (4) before play. Any kind of excitement akes a puppy want to relieve itself.

A puppy should not be housebroken indoors on per. You might not be able to retrain it to relieve itself an outdoor spot. You should not let the puppy get you in the middle of the night. Nor should you allow rain snow to stop you from taking your pet out. Always ke the puppy to its spot during the housebreaking peod. Do not just put it outside and let it find its own way. ter about three days, the puppy will probably not ake any mistakes.

To train a kitten, buy a cat tray and *litter* (artificial nd) at a pet store. Or you can use a box with clean nd. Place the tray near the kitten's food dish, and put e animal into the tray a number of times. A cat instincely buries its body wastes, and so it will use the tray mediately. You should sift the wastes from the litter ily and change the litter weekly.

Tricks. To teach an animal a trick, you must first ke it understand what you want it to do. To teach a g to sit, for example, push it down to a sitting posin. As you do this, say the word *sit.* Praise your pet ien it sits correctly. Soon you will find that whenever u say, "Sit," the dog will sit. To make it sit up, raise its nt feet as you say, "Sit up." A dog can learn many



Jim Collins

Small birds, such as the parakeet shown above, make fine indoor pets. Normally, these birds must be kept caged. But by patient training, this owner taught her pet to sit on her hand.

commands, and such tricks as to fetch, to roll over, to beg, to "say prayers," and to "play dead."

Dogs tire quickly as you train them. You should not work with them more than 15 minutes at a time, and perhaps only once or twice a day. Stop at once if the dog is not paying attention, or if something else seems more interesting to it. You must have the dog's attention, and it must complete each command. Never allow your pet to perform a trick only halfway. And never become impatient when you try to teach it tricks.

Reward a dog with a pat on the head and a few words of praise when it has performed its lesson correctly. If you want to give the animal a special treat, feed it a dog biscuit or a piece of dog candy to exercise its teeth and gums. Ordinary cake, cookies, and candy are bad for a dog and should never be given to the pet.

A cat can be taught to do simple tricks, such as jumping in the air for a ball, leaping over a stick, or walking on its hind legs. You must be patient and gentle to interest the cat in the trick and gain its confidence. Cats should be rewarded with a piece of meat when they perform well. Parakeets usually learn tricks themselves when you put a ladder or toy car in their cages. Fish can learn to come to the side of the tank to receive their food, if you tap gently on the tank each time you feed them.

For work. Most kinds of dogs can be trained to do certain types of work. Dogs can retrieve, or bring back, game for hunters. They can help herd livestock, pull carts or sleds, and perform many other tasks. Careful training will bring the dog to perfect responses. For example, start training retrievers when they are about six months old. To teach a puppy to return an object you have thrown, give a command such as *fetch* as you throw the object. As the dog learns to return the object, throw it farther and farther away. Training in retrieving from the water starts by throwing an object a short dis-

tance into the water. Increase the distance until the dog retrieves the object perfectly.

Taking care of pets

Feeding. The first rule for feeding any pet is to keep its dishes clean. Wash them thoroughly every day. Never overfeed your pet. The animal should always have enough exercise and look sleek and slim. Give a dog only as much food as it will eat without leaving any food in the dish. If it leaves the dish before emptying it, take it away. Feed your pet less the next time. Feeding a dog the right food at regular times helps protect it against sickness.

A balanced diet is necessary if your pet is to be healthy. You can buy prepared food for most kinds of pets. Scientists plan these foods so that they contain the right amounts of vitamins, minerals, and proteins for each type of animal. By using these foods, you can be sure that your pet receives the right nourishment. Prepared foods usually do not need anything added to them. But you may want to give your pet a treat, such as a little horse meat for the dog or cat, or a piece of apple or some greens for the parakeet. Feed your pet at regular times, and be sure that it always has plenty of fresh water.

Housing. All pets must have good houses. Birds should live in cages suitable for their size and activity. For smaller birds, the cage bars should be close enough together so that the bird cannot push its head between the bars and strangle itself. The perches should be $\frac{1}{2}$ inch (1.3 centimeters) in diameter for canaries and parakeets, and 1 inch (2.5 centimeters) in diameter for mynas. Canaries, parakeets, and other flying birds should have room to fly inside the cage. Put their perches at the ends of the cage. Hopping birds, such as finches and mynas, should have the perches nearer to the bottom of the cage and closer together.

A dog or cat should have a warm, dry place for its bed. A basket, box, or pet bed will keep the pet off the floor and protect it from drafts. A dog living outdoors must have a house that is free from drafts. The door of the house should face away from the wind, and it should be covered or sheltered against rain and snow. The house should be just large enough for the animal to stand up and turn around. A house that is too large will be cold.

Cleanliness. Most pets keep themselves clean. Cats sit for hours washing themselves. Birds preen themselves, or clean their feathers with their beaks. Canaries and mynas enjoy hopping in water and splashing around. Parakeets like to roll on wet lettuce leaves or to be sprayed with water from an atomizer.

Dogs and cats should not be bathed too often. Bathing removes the natural oils from their hair and skin. This makes them itch and scratch, and soon they may have open sores. They usually need baths only when they become very dirty. If your dog or cat becomes muddy, wipe off the loose mud, let its coat dry, then brush its coat well.

Treating illness. Most pets will enjoy good health with proper food, housing, and grooming. If one should be hurt, swallow something harmful, or otherwise become ill, it should be taken to a *veterinarian,* or animal doctor.

Don't try to treat your pet's illness yourself, unless you know exactly what is wrong and what to do to remedy the illness. Home treatment may seriously delay finding out what is wrong with your pet, and may even harm the animal.

Preventing illness. Most pet illnesses can be prevented. A veterinarian can vaccinate a puppy to protect it from such fatal diseases as distemper, infectious canine hepatitis, leptospirosis, and rabies. A kitten may be vaccinated against cat distemper and feline leukemia, both deadly cat diseases. Vaccination should begin when the pet is taken from its mother's milk and should continue throughout its life.

A sick animal can infect other animals. By keeping your pet at home, you can lessen its chances of getting sick. A puppy should be kept in the home and yard. If you take it elsewhere, you should keep it on a leash and avoid areas where other dogs—or rats—may be found. An infected dog or rat can spread leptospirosis through its urine.

Tiny parasites, such as fleas, mites, and ticks, may transmit disease germs from a sick animal to a healthy one. Pet stores sell flea collars, powders, and soaps that can rid your pet of these pests.

Birth control. Every year, animal shelters destroy millions of unwanted cats and dogs. Therefore, you should not allow your pet to have babies unless you can be sure they will have a good home.

Veterinarians can prevent an animal from having or fathering babies by *neutering* it—that is, by removing some of its sex organs. This operation is called *spaying* when performed on a female and *castration* when done on a male.

Neutering a pet may also eliminate some kinds of undesirable behavior. For example, castrating a cat before it has had sexual experience can prevent it from chasing females and fighting. Dogs and cats should be neutered at the time the veterinarian considers best for the health and size of the animal. Contrary to popular belief, it is not necessary for the pet to experience its first period of *heat* (sexual excitement) before being neutered. See also **Cat** (Birth control); **Dog** (Social and moral responsibilities). Alan M. Beck

Related articles in *World Book* include:

Bird (As pets)	Guppy	Myna
Canary	Hamster	Parakeet
Cat	Horse	Parrot
Dog	Lovebird	Rabbit
Goldfish	Macaw	Raccoon
Guinea pig	Monkey	Tropical fish

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Zeaman, John. *Before They Were Pets.* 6 vols. Watts, 1998-1999. Traces the natural history of various pets.

Level II

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'ET. See Positron emission tomography.

'étain, *PAY TAN,* **Henri Philippe,** *ahn REE fee LEEP* 856-1951), became a national hero of France because f his military leadership in World War I. Yet he was ied and imprisoned for treason in his old age because f his collaboration with the Germans in World War II.

Military hero. Pétain was born at Cauchy-la-Tour. He vas educated at the French military academy of Saint 'yr and served as an army officer. In 1916, during World Var I, he commanded the French forces in the heroic lefense of Verdun (see **Verdun, Battles of**). Here he poke his famous words "They shall not pass." In April 917, Pétain was made chief of staff. He served as comnander in chief on the Western Front from May 1917 to Aarch 1918. Pétain was nade a Marshal of France n 1918.



Pix

Henri Philippe Pétain

Political career. Pétain erved briefly as minister f war in 1934. His critics ccused him of secret hosility to the French Republic and also of sympathy for he dictatorial government of Francisco Franco in pain. He served as ambasador to Spain in 1939 and 940. Pétain was called ome to be vice premier of rance in the desperate Vorld War II days of May 1940, when France was unble to stop the German invasion. On June 16, 1940, at he age of 84, Pétain became premier. Against the objecions of some of his colleagues, he arranged the armistice with Germany.

Collaborator. Pétain became "chief of state" in the rench government when its capital moved to Vichy. He ccepted collaboration with the Germans as an inescapble necessity. But he also saw it as an opportunity to rehape France along authoritarian lines. His government ndertook measures against Jews, paid heavy financial ribute to the Germans, and sent many French workers o Germany. Pétain's chief supporters included veterans vho had served under him in World War I.

The Germans overran all of France in 1942. But Pétain, hough essentially powerless, insisted on maintaining a alse appearance of French sovereignty. After the Allied roops landed in France in June 1944, the Germans took im to Baden, where he remained until after the war. In 945, Pétain was returned to France. He was tried for reason and was convicted. Pétain died in prison at the ge of 95. John F. Sweets

Petal. See **Flower** (The corolla).

Petate, *pay TAH tay,* is a mat made of dried palm eaves or grass. The poorer people of Mexico and other atin-American countries sleep on petates.

Peter I (1844-1921), a Serbian king, ruled from 1903 to 921. After the death of his father, Prince Alexander, Peter became head of the Karageorgevic dynasty. He became king when the king of Serbia, also named Alexander, was assassinated. Upon assuming the throne, Peter ought help from Russia in acquiring the province of Bosnia. This province, ruled by Austria, was the home of many Slavs. Russia's support of Peter, together with the assassination of Archduke Francis Ferdinand of Austria by Serbs, helped produce World War I. After the war, Serbia and Bosnia became part of the Kingdom of the Serbs, Croats, and Slovenes (later renamed Yugoslavia). Peter retired from the throne in 1914, and his son Alexander served as regent.

Peter was born in Belgrade. As a boy, he and his family lived in exile, and Peter was educated in Hungary and France. R. V. Burks

Peter I, the Great (1672-1725), was one of the most famous rulers in history. He ruled first as *czar* (king) of Russia and later became Russia's first emperor. Peter transformed Russia from an isolated and backward country into a great European power.

Early life. Peter was born in Moscow. His father was Czar Alexis. Alexis died in 1676 and was succeeded as czar by his oldest son, Feodor. Feodor died in 1682. Peter then came to the throne at the age of 10, along with his weak-minded half brother Ivan V. However, Peter's half sister Sophia actually ruled Russia until 1689. Peter's followers forced Sophia to retire that year, and Peter eventually became the sole ruler of Russia.

Peter had been interested in military matters as a youth. He also had enjoyed spending time with foreign military officers who lived in Moscow, and he learned much about European civilization from them. In 1695, a number of these officers helped Peter lead a force against the Ottoman Empire. Peter conquered the Ottoman port of Azov on the Black Sea in 1696.

In 1697 and 1698, Peter toured Western Europe with a group of Russian delegates to seek allies for Russia against the Ottoman Empire. He traveled for about 17 months, mostly in England and the Netherlands. Peter also recruited Western experts to bring modern techniques of engineering, architecture, art, and science to Russia. Russia then lagged far behind other European nations in these areas.

A revolt of his royal guards forced Peter to return to Russia in 1698. Peter crushed the revolt. This victory



Oil painting on canvas (early 1700's) by Louis Caravaque (Granger Collection)

Peter the Great was a powerful ruler who succeeded in bringing Western European culture and customs to Russia.

made him the unquestioned master of Russia.

Foreign policy. From 1700 to 1721, Peter led Russia in a war against Sweden. When the war began, Sweden was the leading power in northern Europe. With the help of his Western advisers, Peter improved Russia's army, created a navy, and made his government more efficient in raising troops and money for his war effort. By the end of the war, Russia had gained control over important territory along the eastern shores of the Baltic Sea. This land gave Russia a direct approach by water to the rest of Europe.

In 1712, the Ottomans forced Peter to turn over the port of Azov and other territories taken earlier from them. But in 1722 and 1723, Peter attacked Persia and conquered territory along the Caspian Sea. Peter's foreign conquests helped Russia greatly to expand its trade with other countries. Peter's conquests also enormously increased Russia's political importance in Europe.

Policies within Russia. One of Peter's chief goals was to end the inefficiency and corruption in Russia's government. Peter strengthened his power as czar and created a senate to supervise the Russian government. He began a policy of appointing people to high military or administrative offices according to merit and seniority. Previously, these appointments were based on family background. Peter also abolished the independence of the Russian Orthodox Church.

Peter's programs led to the expansion of industry and foreign trade and the construction of new roads and canals. He also laid the basis for the Russian Academy of Sciences, started Russia's first newspaper, and founded technical schools, a museum, a public library, and an art gallery. Because of his admiration for European society, Peter forced Russia's nobility to adopt many Western customs.

In 1703, Peter founded the city of St. Petersburg on territory taken from Sweden. He modeled it after cities in Western Europe. Peter made St. Petersburg the capital of Russia and used it as the focus of his efforts to "Westernize" Russian life.

Peter's rule also had some harmful effects. To finance his military campaigns and domestic reforms, Peter imposed high taxes on the Russian people. He also dealt harshly with people who opposed the reforms. Peter forced many Russians to work against their will in his mines and factories and on building projects. Peter also extended serfdom, a system under which the majority of Russian peasants lived in conditions little better than slavery (see **Serf**). James Cracraft

See also **Romanov; Saint Petersburg.**

Additional resources

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Peter II (1923-1970) became king of Yugoslavia at the age of 11 when his father, King Alexander, was assassinated. During his childhood, Peter's cousin Prince Paul served as regent. Peter took the throne in 1941. During World War II (1939-1945), the German army invaded Yugoslavia and Peter set up an exile government in London. He never returned to his country. Communist partisans gained control of Yugoslavia during the war, and established a dictatorship in 1945. Peter was born on Sept. 6, 1923, in Belgrade. See also **Alexander I.**

R. V. Burks

Peter, Epistles of, are the 21st and 22nd books of the New Testament. They are letters from the apostle Peter. Most scholars doubt that Peter actually wrote the letters. They believe the letters were written in his name by someone else. The first Epistle was probably written between A.D. 81 and 96 or 98 and 117, during a persecution of the church by the Roman Empire. The letter's main purpose is to encourage perseverance in Christian faith despite suffering. The second Epistle may have been written as late as A.D. 130 or 140. It is probably the last book of the New Testament to be composed. Its main purpose is to argue that Jesus Christ will some day return, despite doubts that had arisen concerning His Second Coming. Terrance D. Callan

Peter, Saint (?-A.D. 64?), was a leading apostle of Jesus Christ. He was a leader of the early Christian community in Jerusalem and is a prominent figure in the New Testament. Peter's original name was Simon. Jesus gave him the name Peter, which means *rock* in Greek. Peter is sometimes called Simon Peter in the New Testament.

In a passage from the New Testament, Jesus is portrayed as saying to Peter:

"And I say unto thee, That thou art Peter, and upon this rock I will build my church; and the gates of hell shall not prevail against it. And I will give unto thee the keys of the kingdom of heaven: and whatsoever thou shalt bind on earth shall be bound in heaven: and whatsoever thou shalt loose on earth shall be loosed in heaven." (Matt. 16:18-19).

Traditionally, Roman Catholics regard the above passage as evidence that Jesus chose Peter to be the first head of His church. They believe He established the position of pope through Peter. Protestant scholars interpret the passage to mean that Jesus meant His church to be founded on Peter's faith in Him. But both groups agree that Peter led the early Christian community.

Early life. Peter, a Jew by birth, was born in Bethsaida, a town in Palestine on the east bank of the Jordan River. The apostle Andrew was his brother, and the apostle Philip also came from Bethsaida. Peter later moved to the nearby town of Capernaum on the bank of the Sea of Galilee, where he became a fisherman. The New Testament portrays him as warm, generous, stubborn, and impulsive. He was married and may have had children.

Peter and Andrew met Jesus while they were fishermen. Jesus said to the brothers, "Follow me, and I will make you fishers of men" (Mark 1:17). Peter and Andrew left their homes and joined Jesus on His travels.

Life as an apostle. Stories in the New Testament reflect Peter's importance in the Christian community as a close friend of Jesus and His followers. Peter, along with the apostles James and John, is said to have witnessed the Transfiguration (see **Transfiguration**). Jesus also talked with Peter about religious matters. When Jesus asked the apostles about His identity, Peter replied, "Thou art the Christ" (Mark 8:29).

The Gospels suggest that Peter understood Jesus and His significance only after the Resurrection. Before the Crucifixion, Peter denied three times that he knew Jesus. Peter later wept in repentance (Mark 14:72). Peter was one of the first witnesses of the Resurrection listed

by Saint Paul (I Corinthians 15:5). After the Resurrection, Jesus appeared to Peter in a vision. This vision and the faith in Jesus that it produced is the foundation of Christianity. After the Resurrection, Peter became an authority among the Jewish Christians in Jerusalem. He probably served as a peacemaker between conservative Aramaic-speaking Jews led by James and the more liberal Greek-speaking Jews led by Paul. Peter is sometimes called the "Apostle to the Jews."

Later years. Peter apparently left Jerusalem with his wife and became a wandering missionary. According to Christian tradition, Peter became the first bishop of Antioch in Syria, and the first bishop of Rome. He may have died a martyr in Rome during the persecution of Christians by the Emperor Nero from A.D. 64 to 68. According to Christian tradition, Peter was buried under what is now St. Peter's Basilica in Vatican City. There is no conclusive evidence for any event related to his death.

No undisputed writings by Peter have been preserved. Writings by Paul describe Peter as a source of oral stories about Jesus. The New Testament includes two essays called *Epistles of Peter.* The First Epistle, which urges a group of Christian converts to remain faithful in times of persecution, may have been written by Peter. However, the Second Epistle was written by an unknown author sometime during the 100's.

Monuments to Peter, in addition to stories about him, honor him as a missionary and an organizer of the Christian church. By the 100's, a shrine that many believed contained Peter's remains had been built in Rome. The shrine attracted many Christian pilgrims. St. Peter's Basilica stands on the site today. Early Christians honored Peter in art and literature, where he was called the Fisherman, the Rock, and the Shepherd.

By about 450, many Christians believed that the pope was the successor of Peter. They also believed Peter was a saint. June 29 is the feast day of Saint Peter.

David B. Burrell

See also **Jesus Christ; Michelangelo** (picture: *The Crucifixion of Saint Peter); **Peter, Epistles of; Pope.***

Additional resources

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Peter Pan is the boy hero in several fantasies written by the Scottish author J. M. Barrie. The character first appeared in Barrie's novel *The Little White Bird* (1902). Barrie adapted part of the novel into the play *Peter Pan* (1904). Several chapters of the novel were published in 1906 as *Peter Pan in Kensington Gardens.* Barrie also wrote the novel *Peter Pan and Wendy* (1911).

The play *Peter Pan* provides the best-known version of the boy's adventures. In the play, Peter Pan has run away to Never-Never Land to escape growing up. One night, he returns to the human world and meets the three Darling children—Wendy, John, and Michael. Peter persuades them to fly with him and the fairy Tinker Bell back to Never-Never Land. There the Darlings and Peter have many adventures. Other characters include a crocodile, the Indian princess Tiger Lily, and the evil pirate Captain Hook. James Douglas Merritt

See also **Barrie, J. M.; London** (picture).

Peter the Hermit (1050?-1115?) was a monk of Amiens who is famous as a preacher of the First Crusade. Little is known of his life from the time of his birth in Amiens until 1095. At that time he began to preach the necessity of a crusade to get back the Holy Land, which was in Muslim hands. He rode about France on muleback, dressed in a monk's cloak of rough cloth and bearing a crucifix. He hoped to inspire people to join him.

In 1096, Peter set out for Palestine with many undisciplined followers, mostly from the poorer classes. After struggling through Europe and into Asia Minor, most followers were massacred by the Turks. Peter and the survivors joined Godfrey of Bouillon's army and helped capture Jerusalem. William J. Courtenay

See also **Crusades.**

Petersburg (pop. 33,740), in southeastern Virginia, is one of the most historic cities of the South. It lies on the Appomattox River, about 20 miles south of Richmond, Virginia's capital (see **Virginia** [political map]). Petersburg and Richmond and their suburbs form a metropolitan area of 996,512 people.

In 1676, Petersburg's citizens were active in Bacon's Rebellion, a revolt against the English government. The city was attacked and burned in 1781 by British expeditions led by the American traitor Benedict Arnold. During the War of 1812, Petersburg became known as *cockade city* because of the jaunty feathered hats worn by its soldiers. The city was the "last ditch of the Confederacy" during the American Civil War (1861-1865). When Petersburg fell in 1865, the Southern forces evacuated Richmond. General Robert E. Lee, head of the Confederate Army, surrendered soon afterward, ending the war.

The first settlement in Petersburg was made in 1646 near a falls on the Appomattox River. The falls provided a source of power for industrial development, and Petersburg became a major manufacturing center. In the late 1800's, the city was especially known for its tobacco products. Today, Petersburg's chief industries are health care, tourism, and the manufacture of computer software, forest products, optical lenses and frames, roller bearings, and trunks and other storage containers. Virginia State University is in the city. Petersburg has a council-manager government. Susan L. Woodward

See also **Fort Lee.**

Petersburg, Siege of. See **Civil War** (Siege of Petersburg; table: Major battles of the Civil War).

Peterson, Oscar (1925-), is one of the great pianists in the history of jazz. He is known for his brilliant technique and his creative extended solos. He is also a composer and created the expansive composition *Canadiana Suite* (1964).

Peterson was born in Montreal, Canada. He was trained in classical piano from the age of 6. In 1949, Peterson appeared in a "Jazz at the Philharmonic" concert at Carnegie Hall. He quickly achieved fame worldwide. From 1951 to 1966, the Oscar Peterson Trio featured Peterson on piano, Ray Brown on bass, and a third musician on guitar or drums. Most notable were Barney Kessel, Herb Ellis, and Joe Pass on guitar and Ed Thigpen on drums. Peterson has worked with many leading jazz musicians and has performed as guest soloist with several symphony orchestras. Frank Tirro

Peterson, Roger Tory (1908-1996), was an American artist, naturalist, and author. His popular paintings and

illustrations of birds for books led to the development of a series of nature handbooks called the *Peterson Field Guide Series.* His work has helped people identify and appreciate animals in their natural environment and has highlighted the value of wildlife conservation.

Peterson first collected his illustrations and methods of identifying birds in a book called *Field Guide to the Birds* (1934). Later, he created *A Field Guide to Western Birds* (1941). In 1946, he became editor of the *Peterson Field Guide Series.* Peterson expanded the series to include guides on birds of Europe and Mexico, on other animals, on plants, and on minerals.

Peterson was born in Jamestown, New York. His books include *Birds Over America* (1948), *The Birds* (1963), and *Penguins* (1979). With James Fisher, a naturalist, Peterson wrote *Wild America* (1955) and *The World of Birds* (1964). In 1986, Peterson and several colleagues founded the Roger Tory Peterson Institute of Natural History in Jamestown. G. J. Kenagy

Petipa, *peh tee PAH,* **Marius,** *ma RYOOS* (1818-1910), was a great French *choreographer* (creator of dances). Petipa joined the ballet of the Imperial Theatre in St. Petersburg, Russia, in 1847. He was its head from 1862 to 1903. He composed 57 evening-long ballets and many shorter ones. The best known include *Sleeping Beauty, Raymonda, La Bayadère,* and Act III of *Swan Lake.*

Petipa's style is clear and grand. It demands highly trained dancers with a dramatic yet cool and aristocratic quality. Petipa made the St. Petersburg ballet the finest in the world. Its school produced such great dancers as Vaslav Nijinsky, Anna Pavlova, and Michel Fokine.

Petipa was born in Marseille. His father and brother were dancers. Petipa made his debut as a dancer at the age of 20. A leg injury slowed down his career and turned him toward choreography. Katy Matheson

See also Ballet (Ballet in Russia).

Petit, *peh TEE,* **Roland** (1924-), is a French dancer and *choreographer* (creator of dances). After the end of World War II in 1945, he revitalized French ballet by creating a brilliantly stylish and theatrical dance style. Petit's best known work is *Carmen* (1949), which starred his wife, Renée "Zizi" Jeanmaire. He also choreographed such ballets as *Les Forains* (1945), *Le Jeune Homme et la Mort* (1946), and *Paradise Lost* (1967).

Petit was born in Villemomble. After dancing with the ballet of the Paris Opéra from 1939 to 1944, he co-founded the Ballets de Champs-Elysees in 1945. From 1948 to 1959, he was artistic director of the Ballets de Paris de Roland Petit. In 1966, he formed the Ballets de Roland Petit. In 1972, he became artistic director of the Ballet National de Marseille. He also choreographed films and stage revues. Dorothy Lourdou

Petit basset griffon vendéen, *puh TEE bah SAY gree FOHN vohn day OHN,* is a short-legged, rough-coated dog bred to hunt small game, especially hare and rabbit. The name is sometimes abbreviated *PBGV.* The breed originated in Vendée, a region of rough terrain in western France. It is a *scent hound,* which means it hunts by following the scent of the game animal.

The PBGV stands about 13 to 15 inches (33 to 38 centimeters) high at the shoulder and weighs from 30 to 42 pounds (14 to 19 kilograms). Its rough coat is mostly white with orange or gray markings. Its ears are long and narrow and covered by long hair, and it has a mustache and beard. The PBGV is alert, intelligent, and lively and can make a good pet.

Critically reviewed by the Petit Basset Griffon Vendéen Club of America



Shari Kathol

Petit basset griffon vendéens have white coats.

Petit jury. See Jury.

Petit mal. See Epilepsy.

Petit point, *PEHT ee poynt,* is a delicate form of embroidery usually sewed on fine mesh canvas. The term is also used to describe the finished canvas. Petit point is sometimes called *tent stitch* or *half stitch.*

The term *petit point,* which is French, means *small stitch* and refers to the tiny size of the stitches. These tiny stitches slant from left to right and are parallel to one another. The sewer uses a thin needle and fine thread.

Petit point is especially suited for highly detailed designs on such small objects as eyeglass cases, gloves, and handbags. The stitch is also used for embroidering larger canvas panels to decorate furniture seats and backs and canvas pieces that may be framed for display.

People have embroidered petit point since the Middle Ages. However, the term did not appear until the



Detail of sampler (1794); the Henry Francis du Pont Winterthur Museum

Petit point is a tiny stitch used in embroidery. In the example shown above, the church and fence are embroidered in petit point. A larger stitch was used for the surrounding area.

700's in France, when the stitch became popular.
Dona Z. Meilach

See also **Embroidery; Needlepoint.**

etitgrain oil, *PEHT ee GRAYN,* is an oil made by dis-ling the leaves and sometimes the twigs of the bitter range tree. It is used in soaps and in cosmetics. Para-uay is the major supplier of petitgrain oil, but the finest l is produced in southern France. Petitgrain oil also omes from Guinea, Haiti, Spain, and Italy. Petitgrain bi-arade, an oil more valuable than petitgrain oil, is made om the bigarade orange tree, a variety of the bitter or-nge. Patricia Ann Mullen

etition is a written request submitted to a court, a ublic official, or a legislative body. Petitions are often sed to influence the vote on bills in the United States ongress. There is no rule on how a petition shall be re-eived. Officials to whom petitions are sent decide how handle the requests. The First Amendment to the U.S. onstitution guarantees the American people the right o petition the government for a redress of grievances."
Jack M. Kress

etition of Right was a document written in 1628 by e English Parliament and presented to King Charles I. declared unconstitutional certain actions of the king, uch as levying taxes without the consent of Parliament, ousing soldiers in homes, setting up *martial law* (mili-ary government), and imprisoning citizens illegally.

Charles did not like the Petition of Right, but he ac-epted it because he knew of no other way to persuade arliament to vote the funds he had demanded. But he id not intend to carry out his part of the agreement. He ontinued to rule without consent of Parliament until his njust methods brought about his execution in 1649.

The Petition of Right had important results, even hough it did not accomplish its immediate aims. It de-lared, in effect, the supremacy of law over the personal vishes of the king. It also rejected the *divine right of ings,* the belief that monarchs get their right to rule di-ectly from God, rather than from the consent of their ubjects. The petition is a landmark in the history of con-titutional government in England. Charles Carlton

See also **Charles I** (of England).

PETN is short for *pentaerythritol tetranitrate,* an explo-ive more powerful than TNT. It is used as the core of etonating caps and fuses because it is capable of ex-loding in small devices. The combination of PETN and NT is called *pentolite.* In addition, doctors prescribe ETN as an oral medication to treat the symptoms of cer-ain heart disorders. James E. Kennedy

Petoskey stone, *puh TAHS kee,* is a rounded, pol-shed fragment of fossilized coral found near Petoskey, Aich. The fossils come from limestone deposits formed bout 350 million years ago.

The coral occurs in columnlike formations. When cut cross, each column has a six-sided shape within it, ac-ompanied by a pattern of lines that branches out from he center. This structure can be seen most clearly on a mooth, wet surface.

The natural action of water, or grinding and polishing y a craftworker, shapes the fossil into a gem prized by nineral collectors. In 1965, Petoskey stone became Aichigan's state stone. Donald F. Eschman

Petra, *PEE truh,* was an ancient city south of the Dead ea in what is now Jordan. It was an important trading center from the late 400's B.C. to the early A.D. 200's. The city stood on the overland trade route that linked Arabia and the Mediterranean Sea. The Nabataeans, a group of Arabian people, came to power in Petra in the 400's B.C. In A.D. 106, Roman forces conquered Petra and made it part of the Roman Empire. Petra prospered from A.D. 106 to the early 200's. The people built handsome tem-ples on the small plain there, and they cut deeply into the cliffs to make their houses. Petra had often been called the *rose-red city* because of its red stone build-ings and the red cliffs that surrounded it.

About A.D. 235, Petra suddenly stopped making coins, and Palmyra, a city in Syria, took over most of Petra's trade. Petra then became chiefly a religious center. It be-came a Christian city by the A.D. 300's. Muslims captured the city in the 600's. The Franks, a Germanic people, oc-cupied it during the Crusades, and held it until 1189. Soon after, the city was abandoned, and it fell to ruin (see **Jordan** [picture]). Mary Francis Gyles

Petrarch, *PEE trahrk* (1304-1374), was a great Italian lyric poet and scholar. His love poetry has had an unpar-alleled influence on world literature. He was also such a respected scholar that rulers and popes sought his serv-ices. Petrarch led in discovering the greatness of classi-cal writers and helped start the movement later called *humanism.* Such Latin writers as Cicero and Livy might be almost unknown today if Petrarch had not found their lost works buried in monastery libraries.

In his own day, Petrarch's Latin writings were consid-ered revivals of the Greek and Roman style of literature. His intimate knowledge of the classics led to his convic-tion that there is no essential conflict between classical and Christian thought. This conviction anticipated the spirit of the Renaissance.

Throughout his life, Petrarch composed poems of varying length in Italian to praise a beloved woman called Laura. Scholars are not certain that Laura really lived. At first, Petrarch saw in Laura a fleeting image of beauty which he never tired of describing. Eventually he added Christian dimensions to this image of beauty, re-flecting implications of human hopes, aspirations, and duties.

Petrarch wrote more than 400 poems in Italian. Of these, 366 form his *Canzoniere* (*Book of Songs*), on which his reputation rests. Petrarch divided the collec-tion into two parts. The first contains poems presumably written during Laura's lifetime and the second written after her death. In the first part, the reader senses a par-allel between the poet's attempts to define Laura and Apollo's pursuit of Daphne in the famous classical myth (see **Daphne**). In the second part, however, Laura as-sumes the role of a guide, leading her lover toward God and toward ultimate salvation.

The *Canzoniere* includes a roughly chronological his-tory of the poet's overwhelming passion for Laura and ends with a hymn to the Virgin Mary. The work ex-presses a haunting sense of the passage of time and of the vanity of earthly endeavors. It also shows an intense awareness of the conflict between spiritual and earthly values. The tone of the collection alternates bodily pleasure with spiritual love and religious feeling. The poems thus mirror an individual's uneasy condition as being capable of both the lowest depths and the great-est heights. Technically, Petrarch achieved new perfec-

tion in writing the sonnet and the ode, the chief literary forms in the *Canzoniere.* The work influenced such lyric poets as Pierre de Ronsard, Sir Philip Sidney, Luis de Góngora, John Donne, and William Shakespeare.

Petrarch was born Francesco Petracco in Arezzo. He spent most of his productive years in France where his father was in political exile. Richard H. Lansing

Petrel, *PEHT ruhl,* is one of a large group of ocean birds. They range over all the oceans of the world. Petrels seldom come near land except during the breeding season, or when they are blown ashore by storms. They usually nest in protected ledges or in burrows along the shore. Petrels may be black, gray, or white in color. They range from about 6 inches to 3 feet (15 to 91 centimeters) long.

There are many kinds of petrels, including the cahow, *diving-petrels, fulmars, shearwaters, and storm-petrels.* Some petrels feed by diving into the water. But most petrels fly close above the waves and pick up food from the surface. Storm-petrels, which are the smallest petrels, use their feet as paddles just below the surface of the water as they glide above it. They seem to be walking on top of the ocean. Sailors often call storm-petrels "Mother Carey's chickens." Most storm-petrels breed along the Pacific Coast of North America. One species also nests along the Atlantic Coast from Labrador to Maine.

Scientific classification. Petrels are in the family Procellariidae. Storm-petrels make up the subfamily Hydrobatinae.

James J. Dinsmore

See also **Fulmar; Bird** (picture: Birds of the ocean and the Antarctic); **Shearwater.**

Petrified forest, *PEHT ruh fyd,* is made up of tree trunks that were buried in mud, sand, or volcanic ash ages ago and have turned to stone. This action is caused by water that carries dissolved mineral matter. The water seeps through the mud and sand into the buried logs. There it fills the empty cells of the decaying wood with this matter until the structure has become solid stone. This stone shows many details of the original wood structure, especially under the microscope.

Petrified logs are buried in various rock formations from different geologic periods. These fossils represent the types of trees that grew during a certain period. Petrified forests have been found in many states, especially in the Western states and New York.

In the United States, the most famous petrified forest lies in northern Arizona, near the town of Adamana. It covers about 40 square miles (100 square kilometers), which have been set aside as the Petrified Forest National Park. Thousands of petrified logs may be seen lying about on the surface where water has washed away the rock in which they were buried. On the average, the logs measure 3 to 4 feet (0.9 to 1.2 meters) across and 60 to 125 feet (18 to 38 meters) long. Most of them have broken into many pieces and lie scattered about. Only a few logs are still whole and none of them stand upright. The logs were carried there by a flooded river perhaps around 225 million years ago. As they traveled down the river, they were stripped of their branches and leaves. Through the ages, many of the logs have become rainbow-colored. Thousands of people have visited Petrified Forest National Park to see this scenic display.

In life, the logs were the trunks of coniferous trees related to the Norfolk Island pine. Today they consist largely of quartz and opal, two forms of silica. Their yellow, red, purple, and black colorations were produced by impurities of the oxides of iron and manganese.

William D. Tidwell

See also **Fossil; Petrified Forest National Park.**

Petrified Forest National Park, *PEHT ruh fyd,* lies in the Painted Desert in northern Arizona. For the location of the park, see **Arizona** (physical map). The park contains the greatest and most colorful concentration of petrified wood known in the world. Giant logs of agatized wood lie flat on the ground, surrounded by numerous broken sections and fragments. Six "forests" are within the area. The most colorful is called *Rainbow Forest.* The others are named *First, Second, Third, Black,* and *Blue.*

The trees in the area grew about 225 million years

David Muench



A petrified log forms a natural bridge at Petrified Forest National Park in northern Arizona. The logs in the park are probably about 225 million years old.



A prehistoric picture of a mountain lion, *shown here,* was found carved on a rock near Petrified Forest National Park.

© C. Robinson and J. A. Grant, Bruce Coleman Inc.

ago. Fragments of pottery found in the forest show that small groups of farming Indians lived there as early as A.D. 500 to 1400. The area became a national monument in 1906, and a national park in 1962. For the park's area, see **National Park System** (table: National parks).

Critically reviewed by the National Park Service

Petrillo, *puh TRIHL oh,* **James Caesar,** *SEE zuhr* (1892-1984), served as president of the American Federation of Musicians from 1940 to 1958. He continued as president of the union's Chicago branch until 1963. His greatest victory as a labor leader came in 1942 when he forced recording companies to pay a royalty to the musicians for every record they sold. Petrillo fought the use of recorded music whenever it caused musicians unemployment. He barred many great artists from performing on the radio and making records until they joined the union. He was born in Chicago. Jack Barbash

Petrochemicals, *PEHT roh KEHM uh kuhlz,* are chemicals made from petroleum or natural gas. They are among the most important materials used in industry. Manufacturers use petrochemicals in such products as detergents, fertilizer, medicines, paint, plastics, synthetic fibers, and synthetic rubber.

The basic materials of the chemical industry are the *primary petrochemicals.* They may be divided into three major groups, according to their chemical structure: (1) olefins, (2) aromatics, and (3) synthesis gas.

Important olefins include *ethylene, propylene,* and *butadiene.* Ethylene and propylene serve as important sources of industrial chemicals and plastics products. Butadiene is used in making synthetic rubber.

The chief aromatic petrochemicals include *benzene, toluene,* and *xylenes.* Benzene is used in the manufacture of dyes and synthetic detergents. Toluene is used in making explosives. Manufacturers use xylenes in making plastics and synthetic fibers.

Synthesis gas is a mixture of carbon monoxide and hydrogen. The petrochemicals *ammonia* and *methanol* are made from synthesis gas. Ammonia is used in making fertilizer and explosives. Methanol serves as a source for other chemicals.

How petrochemicals are made. Petroleum and natural gas consist chiefly of compounds of the elements hydrogen and carbon. These compounds are called *hydrocarbons.* Most petrochemicals contain carbon that comes from such hydrocarbon compounds.

One important method of producing olefin and aromatic primary petrochemicals is a process called *steam cracking.* In this process, hydrocarbons separated from natural gas or crude oil are mixed with steam in a tubular furnace and quickly heated to between 1,470 and 1,650 °F (800 and 900 °C). The hydrocarbons are thus broken down to simpler compounds, which then combine to form the desired petrochemicals. Primary petrochemicals, especially aromatics, are produced as by-products of petroleum refining.

Complex petrochemicals are made by combining two or more primary petrochemicals. For example, ethylene and benzene can be combined to form *ethylbenzene,* used to make synthetic rubber. Other complex petrochemicals include *polyethylene, polypropylene,* and *polyvinyl chloride.* Manufacturers use these petrochemicals in producing such plastics goods as car parts, electrical insulation, leatherlike clothing and luggage, and squeeze bottles.

History. The first chemical to be made from petroleum or natural gas was produced from natural gas in the United States in 1872. This chemical, *carbon black,* is now used as a reinforcing material in tires.

The widespread use of oil and gas to make chemicals began during the 1920's. Until that time, chemical companies used coal as a source of many chemicals. Then the companies began using petroleum and natural gas to produce the same chemicals because oil and gas were cheaper and easier to obtain than coal. Petrochemicals enabled manufacturers to cheaply produce such materials as plastics and synthetic fibers.

The use of petrochemicals increased rapidly during World War II (1939-1945). The armed forces used many products made from petrochemicals, including explosives and synthetic rubber.

Until the late 1900's, the United States, Japan, and the nations of Western Europe dominated the petrochemical industry. Many nations in the Middle East and Asia then began producing petrochemicals for export rather than merely exporting crude oil and natural gas. Developing and operating petrochemical facilities has helped these countries improve living standards for their people. Geoffrey E. Dolbear

Related articles in *World Book* include:

Alcohol	Gas (Gas products)	Polyvinyl chloride
Ammonia	Hydrocarbon	Rubber
Benzene	Methanol	Textile
Carbon	Petroleum	Toluene
Ethylene	Plastics	

Petrograd. See Saint Petersburg.

Petrolatum, *PEHT ruh LAY tuhm,* also called *petroleum jelly,* is a colorless to yellow, jellylike substance made from petroleum. Petrolatum is used as an ingredient in medicines and cosmetics. It is also sold in stores, often under the trade name *Vaseline.* See also Mineral oil.

Geoffrey E. Dolbear



Top three photos, Standard Oil Company of California; bottom two, WORLD BOOK photos

Most petroleum comes from the earth as a liquid called *crude oil.* Different types of crude oil vary in color and thickness, ranging from a clear, thin fluid to a dark, tarlike substance. In some parts of the world, petroleum also occurs as a solid in certain sands and rocks.

Petroleum

Petroleum is one of the most valuable natural resources in the world. Some people call petroleum *black gold,* but it may be better described as the lifeblood of industrialized countries. Fuels made from petroleum provide power for automobiles, airplanes, factories, farm equipment, trucks, trains, and ships. Petroleum fuels also generate heat and electricity for many houses and business places. Altogether, petroleum provides nearly half the energy used in the world.

In addition to fuels, thousands of other products are made from petroleum. These products range from paving materials to drip-dry fabrics and from engine grease to cosmetics. Petroleum is used to make such items in the home as aspirins, carpets, curtains, detergents, phonograph records, plastic toys, and toothpaste.

Although we use a huge variety of products made from petroleum, few people ever see the substance itself. Most of it comes from deep within the earth as a liquid called *crude oil.* Different types of crude oil vary in thickness and color, ranging from a thin, clear oil to a thick, tarlike substance. Petroleum is also found in solid form in certain rocks and sands.

The word petroleum comes from two Latin words meaning *rock* and *oil.* People gave it this name because they first found it seeping up from the earth through cracks in surface rocks. Today, petroleum is often referred to simply as *oil,* and most of it is found in rocks beneath the earth's surface.

People have used petroleum for thousands of years. But few people recognized its full value until the 1800's, when the kerosene lamp and the automobile were invented. These inventions created an enormous demand for two petroleum fuels, kerosene and gasoline. Since about 1900, scientists have steadily increased the variety and improved the quality of petroleum products.

Petroleum, like other minerals, cannot be replaced after it has been used. People are using more and more petroleum each year, and the world's supply is rapidly running out. If present rates of consumption continue, petroleum may become scarce sometime in the mid-2000's.

Most industrialized nations depend heavily on imported petroleum to meet their energy needs. As a result of this dependence, oil-exporting countries have been able to use petroleum as a political and economic weapon by restricting exports to some of these nations. Oil exporters have also strained the economies of a large number of countries, particularly the poorer ones, by drastically increasing the price of petroleum.

To prevent a full-scale energy shortage, scientists are experimenting with artificial forms of oil and with other sources of fuel. But even if new energy sources appear quickly, people will have to rely on petroleum for many years. Conservation of oil has thus become urgent for

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Robert H. Glaze, Artstreet



Oilways, Exxon Company, U.S.A.

errricks and refineries are familiar symbols of the petroleum industry. A tall steel derrick, *left,* pports the equipment used to drill deep into the earth for petroleum. In a refinery, *right,* crude is processed into fuels and other valuable products.

ery country. People now need to be just as inventive finding ways to conserve petroleum as they have een in finding ways to use it.

Uses of petroleum

Petroleum has a greater variety of uses than perhaps ıy other substance in the world. The reason petroleum ıs so many uses lies in its complicated molecular ructure. Crude oil is chiefly a mixture of many different *hydrocarbons,* which are molecules made up of the elements hydrogen and carbon. Some of these hydrocarbons are gaseous, and some are solid. Most of the hydrocarbons, however, form a liquid.

The mixtures of different hydrocarbons give special characteristics to the *fractions* (parts) of petroleum. Some fractions, such as gasoline and kerosene, are valuable in their natural liquid state. Others must be converted from one state to another or must be combined

etroleum terms

ırrel is the standard unit used to measure crude oil and most etroleum products. One barrel equals 42 gallons (159 liters).

tuminous sands, or *tar sands,* are grains of sand surrounded a black substance that can be processed into oil or gas.

inging in a well means to start the oil flowing in a well.

ude oil is oil as it occurs naturally in a reservoir.

errick is a tall steel structure that holds the equipment used drill an oil well.

ry hole is a well that fails to produce oil or gas in commercial ıantities.

ıhanced recovery is any method of adding energy to a reserır to force oil to flow into a producing well.

action is any of the groups of hydrocarbons that make up ude oil. Fractions are separated during refining.

ydrocarbon is a chemical compound made up of the eleents hydrogen and carbon.

ineral lease is an agreement between an oil company and a operty owner. It gives the company the right to drill for, and produce, oil on the property.

ffshore wells are wells drilled in oceans, seas, or lakes.

Oil field is an area that contains one or more reservoirs.

Oil shale is a sedimentary rock containing *kerogen,* a substance that can be processed into oil.

Oil trap is a nonporous, underground rock formation that blocks the movement of oil and so seals off a reservoir.

Petrochemicals are chemicals processed from oil and gas.

Primary recovery is a method in which the natural energy in a reservoir is used to bring oil into a producing well.

Reservoir is an accumulation of petroleum below the earth's surface. It consists of tiny drops of oil that collect in the pores of such rocks as limestone and sandstone.

Rig consists of the derrick, hoisting machinery, and other equipment used in drilling an oil well.

Roughneck is a worker on a drilling crew.

Royalty is money paid to landowners for oil produced on their property. Most oil companies pay a royalty of one-eighth to one-sixth the value of each barrel of oil produced and sold. Landowners may also take royalties in oil.

Wildcat well is a well drilled in an area where no oil or gas has been found.

with different substances before they can be used.

Various types of crude oil contain different amounts of certain fractions. *Light crudes* have large amounts of dissolved gases, gasoline, and other light fractions. Most *heavy crudes* have a high proportion of heavy oils and asphalt. All crude oil contains some substances in addition to hydrocarbons. These impurities, which include metallic compounds and sulfur, may make up as much as 10 per cent of some types of oil.

Petroleum refineries separate the various fractions and change them into useful products. Most crude oil is refined into gasoline, heating oil, and other fuels. The rest of the oil is converted chiefly into industrial raw materials and lubricants.

Petroleum as a fuel. Petroleum fuels ignite and burn readily and produce a great amount of heat and power in relation to their weight. They are also easier to handle, store, and transport than such other fuels as coal and wood. Petroleum supplies about 43 per cent of the energy consumed in the United States. It is the source of nearly all the fuels used for transportation and of many fuels used to produce heat and electricity.

Fuels for transportation include gasoline, diesel fuel, and jet fuel. About 45 per cent of all crude oil is refined into gasoline, about 7 per cent into diesel fuel, and about 7 per cent into jet fuel.

Gasoline is classified into regular, premium, and aviation grades, according to how smoothly it burns in an engine. Most motor vehicles and all piston-engine airplanes use gasoline. Diesel fuel requires less refining and is cheaper than gasoline. Nearly all trains, ships, and large trucks use diesel fuel. Jet airplanes burn jet fuel, which is either pure kerosene or a mixture of gasoline, kerosene, and other fuels.

Fuels for heating and energy production account for about 26 per cent of all refined petroleum. Such fuels may be classed as *distillate oils* or *residual oils.* Distillate oils are lighter oils, most of which are used to heat houses and small business places. Residual oils are heavier, thicker oils. They provide power for electric utilities, factories, and large ships. Residual oils are also used to heat large buildings.

Many people who live on farms or in mobile homes use *liquefied petroleum gas* (LPG) for heating and cooking. LPG consists chiefly of butane and propane gases that have been converted under pressure into liquids. LPG is used in industry for cutting and welding metals and on farms for operating various kinds of equipment.

Petroleum as a raw material. About 13 per cent of petroleum fractions serve as raw materials in manufacturing. Many of these fractions are converted into *petrochemicals,* which make up more than a third of all the chemicals produced in the United States. Petrochemicals are used in manufacturing cosmetics, detergents, drugs, fertilizers, insecticides, plastics, synthetic fibers, and hundreds of other products.

By-products of petroleum refining are also used as raw materials in certain industries. These by-products include asphalt, the chief roadbuilding material, and wax, an essential ingredient in such products as candles, milk cartons, and furniture polish.

Other uses of petroleum. Such products as lubricants and specialized industrial oils account for about 2 per cent of petroleum production. Lubricants reduce friction between the moving parts of equipment. They range from the thin, clear oil used in scientific instruments to the heavy grease applied to aircraft landing gear. Specialized industrial oils include *cutting oils* and *electrical oils,* which are used in manufacturing.

Where petroleum is found

Petroleum is found on every continent and beneath every ocean. But present-day techniques enable petroleum engineers to *recover* (bring to the surface) only about a third of the oil in most deposits. These recoverable amounts of petroleum are called *reserves.*

Petroleum experts estimate that the world's oil reserves total about 1 trillion barrels. Some geologists predict that additional reserves will be discovered, particularly in China, on Canadian islands in the Arctic Ocean, and in offshore seabeds. However, many experts think that most of the major oil fields have already been found. They believe that world reserves are more likely to be increased by better methods of recovery than by new discoveries of oil.

The Middle East has about 67 per cent of the world's oil. Its reserves total about 660 billion barrels. Saudi Arabia has about 258 billion barrels, or about a fourth of the world's reserves. Most of Saudi Arabia's petroleum lies in areas along the Persian Gulf. Abu Dhabi, Iran, Iraq, and Kuwait each have about a 10th of the total world petroleum reserves.

Europe, including the Asian part of Russia, has about 7 per cent of the world's oil supply. Russia, with about

Some uses of petroleum products

Fuels

For transportation
- Aviation gasoline
- Diesel fuel
- Gasoline
- Jet fuel
- Kerosene

For heating and energy production
- Distillate oils
- Liquefied petroleum gas (LPG)
- Residual oils

Raw materials
- Asphalt
- Carbon black
- Coke
- Industrial hydrogen
- Naphtha
- Wax

Miscellaneous oils
- Lubricating oils and greases
- Medicinal oils
- Road oils
- Technical oils

Petrochemicals
- Alcohol
- Ammonia
- Cosmetics
- Drugs
- Dyes
- Explosives
- Fertilizers
- Fibers
- Food additives
- Gasoline additives
- Ink
- Insecticides
- Paint
- Plastics
- Resins
- Solvents
- Synthetic rubber

7 billion barrels, has the largest reserves in the region. Most of these reserves lie west of the Ural Mountains, though there are several large oil fields in Siberia. The only other major European reserves, which amount to about 17 billion barrels, are beneath the North Sea. These reserves belong chiefly to Great Britain and Norway.

Latin America has about 120 billion barrels of petroleum reserves, or 12 per cent of the world's total. Venezuela has the largest reserves in the region, about 59 billion barrels. Huge deposits of heavy oil lie north of the Orinoco River in eastern Venezuela. The other major oil region in Venezuela is the Lake Maracaibo Basin in the northwestern part of the country. Light and medium grades of crude oil lie in this area. Mexico has the second largest reserves in Latin America, about 52 billion barrels. Most of Mexico's reserves lie in the eastern part of the country, along the Gulf of Mexico. Other Latin American countries with important petroleum deposits include Argentina and Brazil.

Africa possesses about 60 billion barrels of oil, or 6 per cent of the world's reserves. Most of the oil lies in Libya, Algeria, and other countries in northern Africa. Libya's reserves of about 23 billion barrels rank as the region's largest. South of the Sahara, large amounts of oil have been found only in Nigeria, which has about 17 billion barrels.

Asia, excluding the Asian part of Russia and the Middle East, has about 50 billion barrels of oil, or 5 per cent of the world's reserves. About half these reserves lie in China. China's largest oil field is at Daqing in Manchuria. Other major Chinese deposits lie on the Shandong Peninsula and in the province of Xinjiang. Indonesia, with about 11 billion barrels, has the second largest reserves in the Far East.

The United States and Canada have about 32 billion barrels of oil, which amounts to 3 per cent of the world total. The United States has about 26 billion barrels of petroleum. Most of these reserves lie in Texas, Louisiana, California, Oklahoma, and Alaska. In time, U.S. reserves may be increased by oil produced from *oil shale,* a type of rock that is plentiful in Colorado, Wyoming, and Utah. Oil shale contains *kerogen,* a waxy substance that yields oil when heated.

Most of Canada's 6 billion barrels of oil lie in the province of Alberta. Saskatchewan, British Columbia, and Manitoba also have oil fields. In addition, geologists believe that Canada has the world's largest deposits of



Arabian American Oil Company

The Middle East has about two-thirds of the world's oil. About a fourth of the total reserves lie in Saudi Arabia. Many nations depend on Middle Eastern oil to meet their energy needs.



Gamma from Liaison

Offshore wells provide about 25 per cent of the oil produced in the world. The North Sea, which has some of the richest offshore deposits, is a major source of oil for Western Europe.



© Alan Orling, Black Star

Bituminous sands, or *tar sands,* can be processed into petroleum. The world's largest deposits of these sands lie along the Athabasca River in the Canadian province of Alberta.



Steve Northup, Camera 5

Oil shale contains a substance that yields oil when heated. Huge deposits of oil shale in Colorado, Wyoming, and Utah may someday provide more oil than the oil fields of the Middle East.

bituminous sands, or *tar sands* (sands soaked with an oil-producing substance). These deposits, which are estimated to contain up to a trillion barrels of oil, lie along the Athabasca River in Alberta. Production of oil from the sands began in 1967.

How petroleum was formed

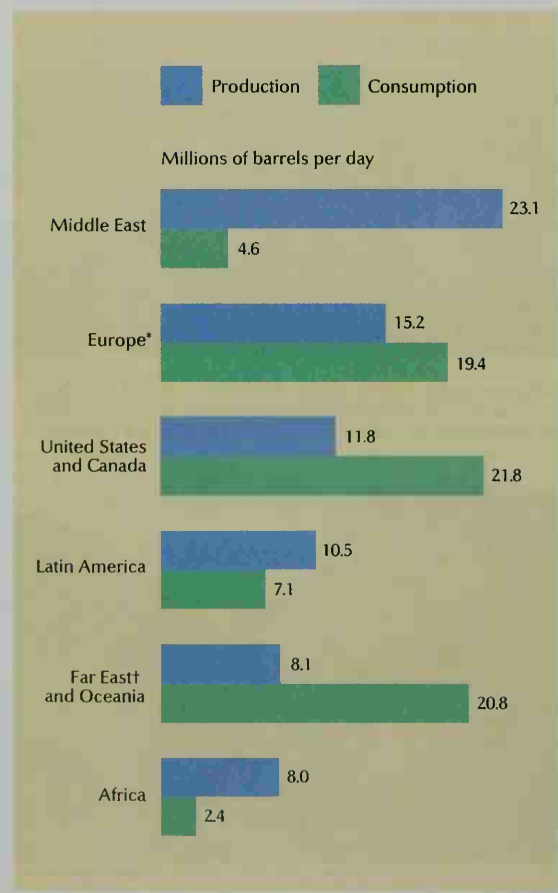
Most geologists believe petroleum was formed from remains of organisms that died millions of years ago. This *organic theory* of petroleum formation is based on the presence of certain carbon-containing substances in oil. Such substances could have come only from once-living organisms. The process that produced petroleum also produced natural gas. Thus, natural gas is often found in association with crude oil or dissolved in it.

According to the organic theory, water covered much more of the earth's surface in the past than it does today. Masses of tiny organisms lived in shallow water or drifted around near the surface in the open ocean. As these organisms died, their remains settled to the bottom of the ocean and became trapped in *sediments* (particles of mud, sand, and other substances). The sediments piled up and became buried below the surface of the ocean floor.

As the sediments became buried deeper and deeper, they were subjected to increasingly high temperatures and pressures, and so were compressed to form *sedimentary rock.* These conditions caused the rock to go through chemical processes that resulted in the formation of a waxy substance called *kerogen.* Kerogen separates into a liquid (oil) and a gas (natural gas) when it is heated to temperatures above about 212 °F (100 °C). But if the oil becomes buried too deeply and is exposed to temperatures higher than about 400 °F (200 °C), the bonds holding the large, complex oil molecules together weaken and the oil decomposes. The temperature range in which oil can form is called the *oil window.* At temperatures below this range, little oil forms. At great depths, where temperatures are high, most oil decomposes.

World production and consumption of petroleum

This graph shows the amounts of petroleum produced and used in various regions of the world. The Middle East produces about five times as much petroleum as it consumes. However, most regions consume more oil than they produce.



*Includes the Asian part of Russia.
†Excludes the Asian part of Russia.
Figures are for 2000.
Source: U.S. Energy Information Administration.

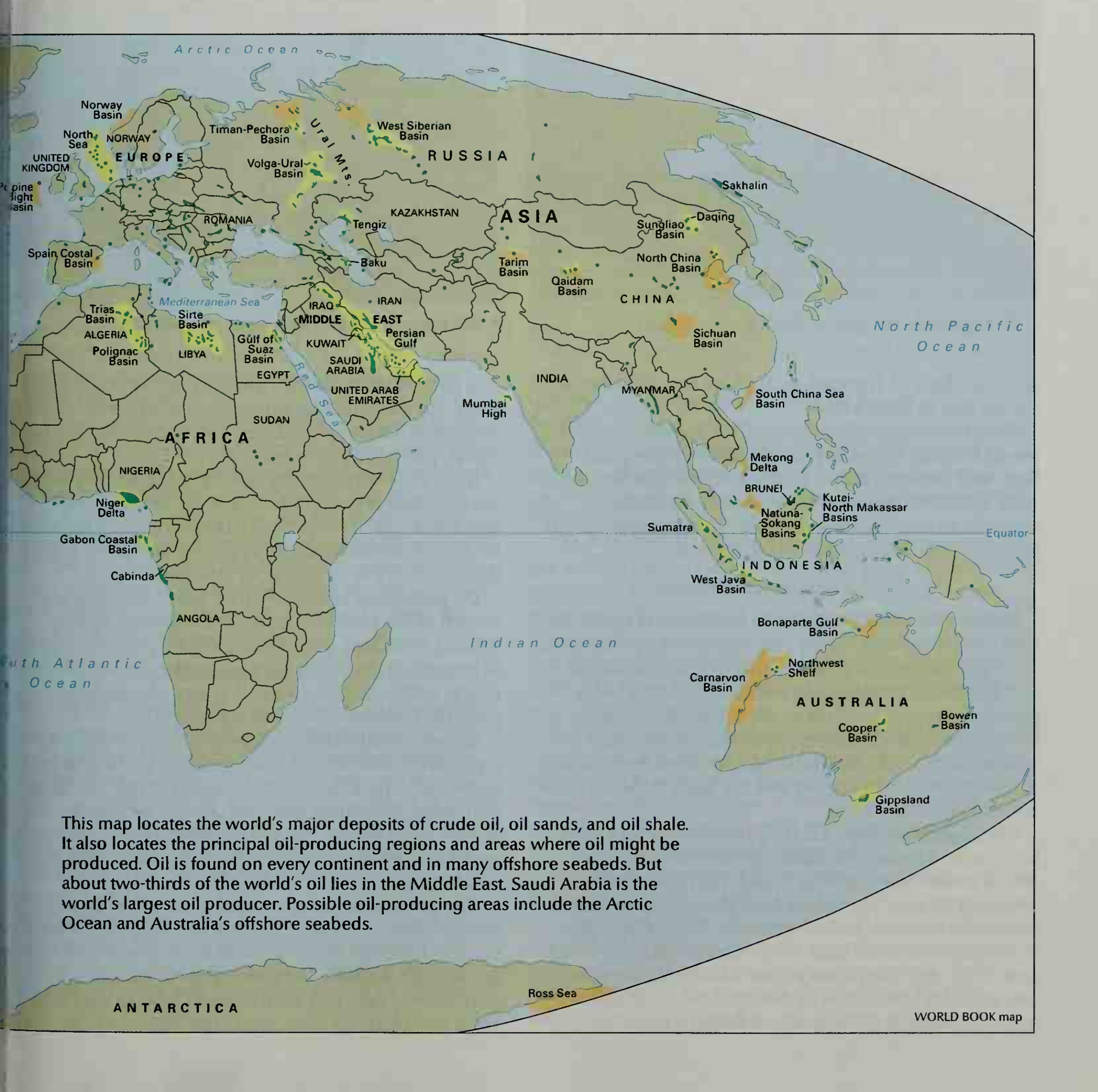


Over time, the oil and gas moved upward through ıtural passageways in the rock. These passageways inıded cracks and tiny holes known as *pores.* Geologists lieve this movement may have been caused by the esence of water in the rock. Water, which is more nse than oil, could have pushed the oil upward. Anıer possible cause was the weight of the overlying ers of rock, which would tend to squeeze the oil into les and cracks in the rock.

Oil and gas escaped to a type of rock called *reservoir ck.* Such rock has two characteristics that enable fluids move through it: (1) porosity and (2) permeability. rosity is the presence of small openings, or pores. rmeability means that some of the pores are connect- by spaces through which fluids can move. Oil and s moved upward through the connected pore spaces itil they reached an impermeable layer of rock. They ntinued to escape along the underside of the impereable layer until that layer formed some sort of threemensional *trap.* Later, shifts in the earth's crust caused the oceans to draw back. Dry land then appeared over many reservoir rocks and traps.

The most common types of petroleum traps are *anticlines, faults, stratigraphic traps,* and *salt domes.* An anticline is an archlike formation of rock under which petroleum may collect. A fault is a fracture in the earth's rocky outer shell. Rock can shift along a fault, moving an impermeable layer of rock next to a permeable one that contains oil. Most stratigraphic traps consist of layers of impermeable rock that surround oilbearing rocks. In a salt dome, a cylinder- or cone-shaped formation of salt pushes up through sedimentary rocks, causing the rocks to arch and fracture in its path. Petroleum may accumulate above or along the sides of such a formation.

Most reservoirs and traps lie deep beneath the surface of the earth. However, some reservoirs have formed near the surface, and others have been shifted upward by changes in the earth's crust. Oil from these shallow deposits may reach the surface as *seepages* (trickles) or springs. In some places, such as Venezuela

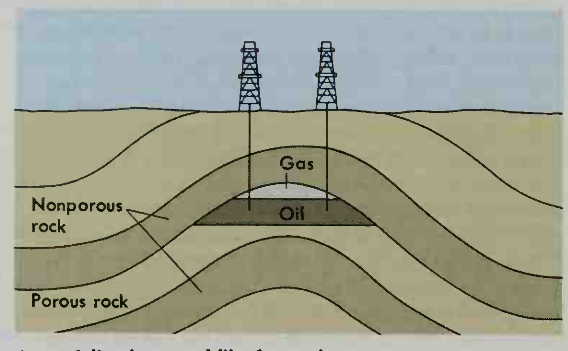


This map locates the world's major deposits of crude oil, oil sands, and oil shale. It also locates the principal oil-producing regions and areas where oil might be produced. Oil is found on every continent and in many offshore seabeds. But about two-thirds of the world's oil lies in the Middle East. Saudi Arabia is the world's largest oil producer. Possible oil-producing areas include the Arctic Ocean and Australia's offshore seabeds.

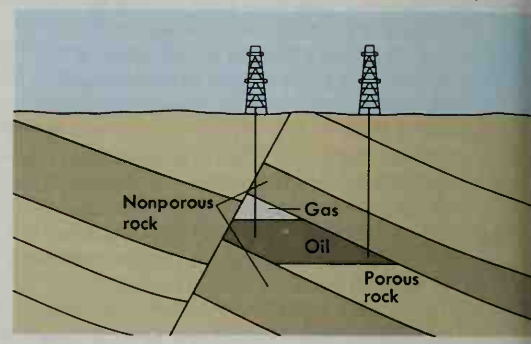
Where petroleum is found

Most crude oil lies in underground formations called *traps.* In a trap, petroleum collects in the pores of certain kinds of rock. Gas and water are also present in most traps. The most common types of traps are *anticlines, faults, stratigraphic traps,* and *salt domes.*

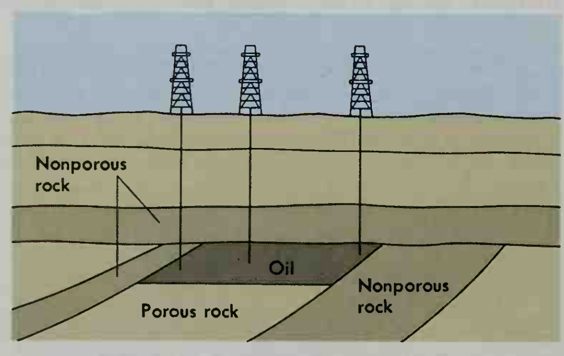
WORLD BOOK illustrations by Robert Ke



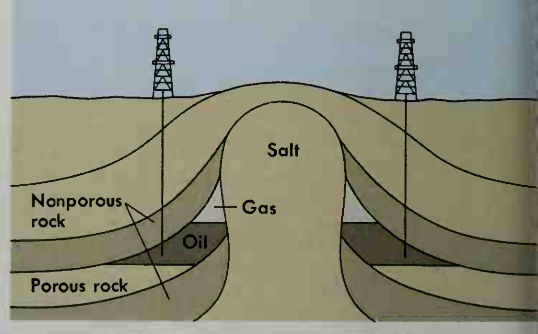
An anticline is an archlike formation.



A fault is a fracture in the earth's rocky outer shell.



A stratigraphic trap has horizontal layers of rock.



A salt dome is formed by a large mass of salt.

and the island of Trinidad, enough oil has collected at the surface to form a lake.

Today, the organic matter in some sedimentary deposits is being subjected to conditions of pressure, heat, and bacterial action similar to those that formed oil ages ago. But it takes millions of years for useful amounts of oil to develop. People are consuming petroleum much faster than it is being formed.

Exploring for petroleum

Before about 1900, petroleum prospectors could do little more than look for oil seepages and hope for luck. Their equipment consisted chiefly of a pick, a shovel, and possibly a *divining rod,* a forked stick that some people believed could magically locate oil or water. During the 1900's, however, petroleum exploration developed into a science. Today, prospectors use a variety of complicated instruments and are likely to be *oil geologists* or *geophysicists.*

Geological studies. Oil geologists study rock formations on and below the earth's surface to determine where petroleum might be found. They usually begin by selecting an area that seems favorable to the formation of petroleum, such as a sedimentary basin. Geologists then make a detailed map of the surface features of the area. They may use photographs taken from airplanes and satellites in addition to their ground-level observations, particularly if the area is difficult to cover on foot. The geologists study the map for signs of possible oil traps. For example, the appearance of a low bulge on a[n] otherwise flat surface may indicate the presence of a sa[lt] dome, a common petroleum trap.

If the site looks promising, oil geologists may obtain *cores,* which are cylindrical samples of the underground layers of rock. The geologists analyze the cores for chemical composition, structure, and other factors that relate to the formation of petroleum.

Oil geologists also study *well logs.* A well log is a record of the rock formations encountered during drilling. Well logs describe the depth, porosity, and fluid content of the rocks. Oil geologists use this information to estimate the location and size of possible deposits in the area surrounding the wells.

Geophysical studies. Geophysicists provide oil geol[-]ogists with detailed information about underground an[d] underwater rock formations. Geophysicists can locate geological structures that may contain oil with the aid o[f] special instruments. The most widely used instruments are (1) the gravimeter, (2) the magnetometer, and (3) the seismograph.

The gravimeter (pronounced *gruh VIHM uh tuhr*), or gravity meter, measures the pull of gravity at the earth's surface. Different kinds of rocks have different effects o[n] gravity. For example, nonporous rocks tend to increase gravitational pull, and porous rocks tend to decrease it. Thus, low readings on a gravimeter may show the pres-

ce of possibly oilbearing, porous layers of rock. Gra-
neters are particularly effective in detecting salt
mes because salt decreases the pull of gravity more
n most rocks do.

The magnetometer (MAG *nuh TAHM uh tuhr*) records
anges in the earth's magnetic field. The magnetic pull
the earth is affected by the rocks beneath its surface.
dimentary rocks generally have lower magnetism
n other types of rock, which may contain iron and
ner magnetic substances. This difference in magnetic
ll enables geophysicists to identify sedimentary rock
t may contain oil. In addition, magnetic pull is af-
ted by structural irregularities, such as anticlines and
lts. Magnetometers may thus detect some petroleum
ps.

The seismograph (*SYZ muh graf*) measures the
eed of sound waves traveling beneath the earth's sur-
e. This speed depends on the type of rock through
ich the sound waves move. Geophysicists can use the
eeds and travel times to determine the depth and
ape of many potential traps.

In a seismographic survey, geophysicists may set off a
all explosion at or just below the earth's surface. The
und waves generated by the explosion travel to un-
rground layers of rock and bounce back to the sur-
e. The seismograph records how long it takes the
und waves to reach the surface. Many geophysicists
e a system called *vibroseis* (*vy BROH see ihs*) to elimi-
te the environmental risks of using explosives. In this
stem, sound waves are produced by a huge vibrator
at repeatedly strikes the earth. The vibrator is
ounted on a special truck called a *thumper truck.*

Geophysicists also conduct seismographic surveys of
shore areas. They send an electronic pulse or
mpressed-air discharge from a ship into the water.
e resulting sound waves are reflected from underwa-
formations to seismographic equipment that is
wed behind the ship.

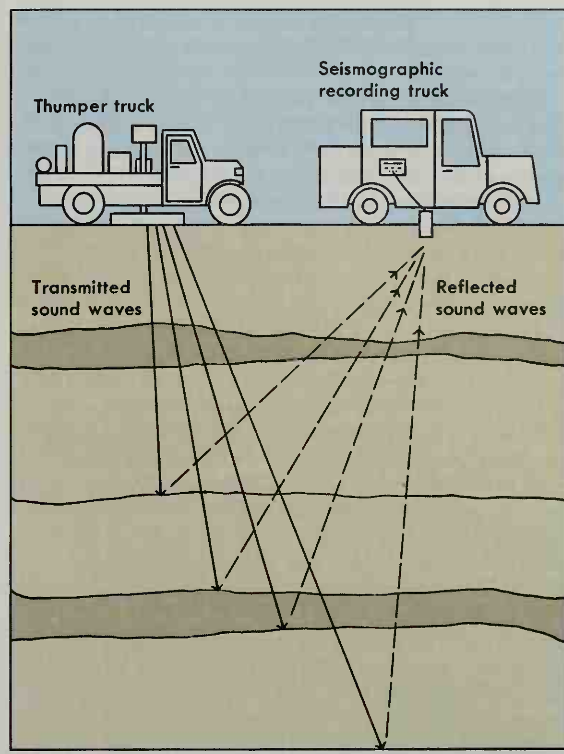
By means of a technique called *bright spot technol-
y,* geophysicists can use seismographs to detect the
esence of fluids in underground and underwater rock
rmations. This technique involves the use of highly
nsitive recorders that pick up changes in the *ampli-
de* (height) of sound waves. Sound waves change in
plitude when they are reflected from rocks that con-
n gas and other fluids. Such changes appear as irreg-
arities, called *bright spots,* on the sound wave pat-
ns recorded by the seismograph.

Drilling an oil well

Drilling for petroleum is nearly always an enormous
mble. Most geological and geophysical studies indi-
te the places where petroleum might have accumu-
ed. However, there is less than a 10 per cent chance
at oil is actually present in those places. There is only a
er cent chance that it is present in those places in
mmercially useful amounts. Many *dry holes* may be
illed before a producing well is *brought in* and the oil
gins to flow.

Preparatory measures take place both on and off
e drilling site. They include (1) obtaining leases and
rmits, (2) preparing the site, and (3) rigging up.

Obtaining leases and permits. In the United States,
companies must deal with the owner of a site—or



WORLD BOOK illustration by Steven Liska

Sound waves can help find oil. A method called *vibroseis* operates on the principle that the speed of sound waves varies according to the type of rock through which they travel. Vibroseis thus enables geophysicists to locate rocks that may contain oil. In this method, a *thumper truck* produces sound waves. Another truck holds a *seismograph,* an instrument that records the time in which underground rocks reflect the waves to the surface.

with the government if the site is on public property—for permission to drill. Most companies obtain a *mineral lease,* which gives them the right to drill wells and to produce oil and gas on the site. In return, the owner generally receives *royalties* (shares of the income) from any oil and gas recovered.

After obtaining a mineral lease, an oil company must get drilling permits from the federal, state, and local governments. Before such permits are issued, a company has to meet certain requirements. In most cases, for example, a company must submit studies of the effect drilling will have on the environment. A company must also show how it intends to conserve natural resources and prevent waste.

In Canada, most of the mineral rights for land and offshore areas are owned by the federal or provincial governments. Oil companies therefore obtain most mineral leases from the government. The companies are then required by law to begin certain exploratory work on the leased area within a specified period.

Preparing the site. A drilling site must be flat and free of trees and brush to make room for drilling operations. In most locations, bulldozers are used to clear and level the ground. If an area has rough terrain or a harsh climate, additional preparation may be required. On Alaska's North Slope, for example, drilling sites had to be reinforced with gravel and wood. If these measures had

not been taken, the heat generated by the drilling equipment might have thawed the frozen soil and caused the wells to collapse.

Roads must be built to the drilling site. The site must also have a power plant and a water supply system. If the location is far from a city or town, or offshore, living quarters may have to be set up for the crew.

After the drilling site has been prepared, the construction crew brings in the *rig,* which consists chiefly of drilling equipment and a derrick. The rig may be transported by truck, bulldozer, barge, or aircraft, depending on the location of the site.

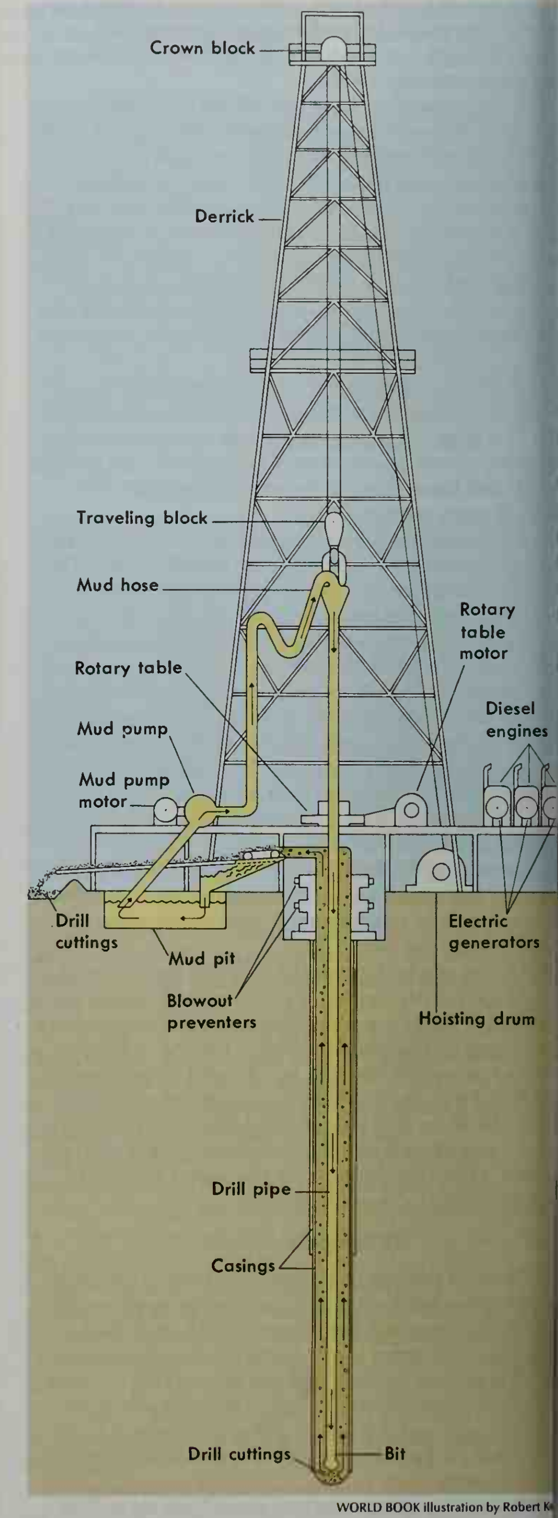
Rigging up is the process of setting up and connecting the various parts of the rig. First, the construction crew erects the derrick over the spot where the well is to be drilled. Derricks serve mainly to hold the hoisting machinery and other drilling equipment. The hoisting machinery, which includes pulleys, reels, and heavy wire, lowers the drill into the well hole and hoists it out. Derricks range in height from 80 to 200 feet (24 to 61 meters), depending on the estimated depth of the oil. Most construction crews use a *jackknife derrick,* which consists of two or more sections that can be easily transported and assembled.

Next, the crew installs the engines that power the drill and other machinery on the rig. The workers also assemble the various pipes, tanks, pumps, and other drilling equipment. After the drill is attached to the hoisting machinery, the well hole can be *spudded in* (started) by any of several methods of drilling.

Methods of drilling. The first oil crews in the United States used a drilling technique called *cable-tool drilling,* which is still used for boring shallow holes in hard rock formations. Today, however, most American crews use a faster and more accurate method called *rotary drilling.* On sites where the well must be drilled at an angle, crews use a technique called *directional drilling.* In addition, petroleum engineers are testing a variety of methods to increase the depth of oil wells and reduce the cost of drilling operations.

Cable-tool drilling is a simple process. It works much as a chisel is used to cut wood or stone. In this method, a steel cable repeatedly drops and raises a heavy cutting tool called a *bit.* Bits may be as long as 8 feet (2.4 meters) and have a diameter of 4 to $12\frac{1}{2}$ inches (10 to 31.8 centimeters). Each time the bit drops, it drives deeper and deeper into the earth. The sharp edges of the bit break up the soil and rock into small particles. From time to time, the workers pull out the cable and drill bit and pour water into the hole. They then scoop up the water and particles at the bottom of the hole with a long steel pipe known as a *bailer.* The crew for cable-tool drilling generally consists of a *driller,* who operates the equipment on the rig, and a *tool dresser,* who sharpens the bit and does other jobs.

Rotary drilling, like cable-tool drilling, works on a simple principle. The drill bores through the ground much as a carpenter's drill bores through wood. The bit on a rotary drill is attached to the end of a series of connected pipes called the *drill pipe.* The drill pipe is rotated by a turntable on the floor of the derrick. The pipe is lowered into the ground. As the pipe turns, the bit bores through layers of soil and rock. The drilling crew adds lengths of pipe as the hole becomes deeper.



WORLD BOOK illustration by Robert K

A rotary-drilling rig includes a derrick and the machinery that raises and lowers the drilling equipment. As the *drill pipe* is lowered, it is turned by a *rotary table.* The *bit* at the end of the drill pipe bores through the earth. Mud is pumped through the well to clean the bit and bring up *cuttings* (pieces of rock).

The drill pipe is lowered and raised by a hoisting ıechanism called the *draw works,* which operates ɔmewhat like a fishing rod and reel or a pair of pulleys. teel cable is unwound from the *hoisting drum,* a kind f reel. The cable is then threaded through two *blocks* ets of pulleys)—the *crown block,* at the top of the rig, ıd the *traveling block,* which hangs inside the derrick. ıe workers attach the upper end of the drill pipe to the aveling block with a giant hook. They can then lower ıe pipe into the hole or lift it out by turning the hoisting rum.

During rotary drilling, a fluid called *drilling mud* is umped down the drill pipe. It flows out of the openıgs in the bit and then back up between the pipe and ıe wall of the hole to just below the derrick floor. This ɔnstantly circulating fluid cools and cleans the bit and ırries *cuttings* (pieces of soil and rock) to the surface. ıus, the crew can drill continuously without having to ail out the cuttings from the bottom of the well. The rilling mud also coats the sides of the hole, which elps prevent leaks and cave-ins. In addition, the presıre of the mud in the well reduces the risk of *blowouts* ıd *gushers,* which are caused by the sudden release of ressure in a reservoir. Blowouts and gushers may deroy the rig and waste much oil.

The drilling crew changes the bit when it becomes ull or if a different type of bit is needed. Different bits e used for hard and soft rocks. Each time the workers ıange the bit, they must pull out the entire drill pipe, hich may be longer than 25,000 feet (7,620 meters). As ıe drill pipe is raised from the well, the crew disconnects the lengths of pipe and stacks them inside the derrick. After the new bit has been attached, the workers lower the pipe back into the hole.

Most rotary-drilling crews consist of a *driller,* one or more *derrickmen,* and several workers known as *roughnecks.* Crews work around the clock, rotating in 8- or 12-hour shifts called *tours* (pronounced *TOW uhrz*).

Directional drilling. In cable-tool drilling and most rotary drilling, the well hole is drilled straight down from the derrick floor. In directional drilling, the hole is drilled at an angle. Drilling crews may use special devices called *turbodrills* and *electrodrills.* The motors that power these drills lie directly above the bit and rotate only the lower section of the drill pipe. Such drills enable drillers to guide the bit along a slanted path. Drillers may also use tools known as *whipstocks* to drill at an angle. A whipstock is a long steel wedge grooved like a shoehorn. The wedge is placed in the hole with the pointed end upward. The drilling path is slanted as the bit travels along the groove of the whipstock.

Many crews adopt directional drilling to drill more than one well at a site. The method is also used if a well cannot be drilled directly over an oil deposit. For example, oil lay beneath the State Capitol in Oklahoma City. By means of directional drilling, a hole was drilled to the oil from 400 feet (120 meters) away.

Experimental methods of drilling include the use of electricity, intense cold, and high-frequency sound waves. Each of these methods is designed to shatter the rocks at the bottom of the hole. Petroleum engineers are also testing a drill that has a bit with a rotating surface.



© Dan Connolly, Sygma

embers of a drilling crew, called *roughnecks,* prepare to ıange the bit. As the drill pipe is raised, the workers disconıct the lengths of pipe and stack them in the derrick.



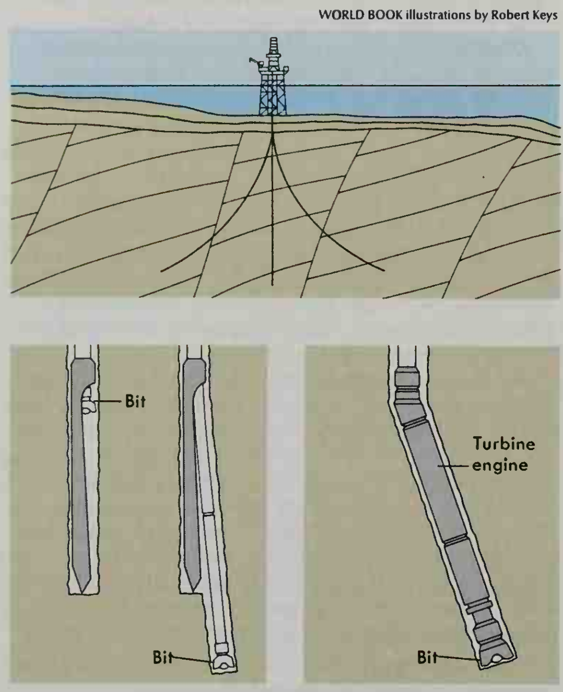
Continental Oil Company, American Petroleum Institute

The bit is changed when it becomes dull or if a different type of bit is needed. A large-toothed bit, *above,* is used to drill through soft rock, such as limestone or sandstone.

Directional drilling

In directional drilling, an oil well is drilled at an angle rather than straight down. Crews use such tools as *whipstocks* and *turbodrills* to guide the bit along a slanted path. This method is often used in offshore operations because many wells can be drilled directionally from one platform.

WORLD BOOK illustrations by Robert Keys



Whipstock

Turbodrill

By means of remote control, drillers could rotate the bit to expose a new drilling surface. Such a bit would eliminate the need to pull the drill pipe out of the hole each time the bit is changed.

Offshore drilling is much more expensive and dangerous than drilling on land. The average offshore rig costs 10 times more than a land rig. All the equipment and the crew must be brought to the site by helicopter or ship. In such waters as the Arctic Ocean and the North Sea, rigs may be damaged by storms or floating blocks of ice. But as the number of land reserves declines, the importance of offshore wells increasingly outweighs their higher costs and risks.

Drilling an offshore well is similar to drilling a well on land. The parts of the drilling rig are the same. But an offshore rig must be mounted on something that can be taken to sea. Most exploratory wells are drilled from such movable rigs as *jack-up rigs, semisubmersible rigs,* or *drillships.* A structure called a *fixed platform* is used for oil production.

Jack-up rigs are commonly used in water depths of up to 200 feet (60 meters). But some jack-up rigs can be used in depths of up to 350 feet (110 meters). The rig rests on a floating platform attached to steel legs that can be jacked up or down. To move the rig, workers lower the platform into the water and jack up the legs off the ocean floor. Boats generally tow the rig to the new drilling site. There, the legs are again lowered to the ocean floor, and the floating platform is jacked up clear of the water's surface.

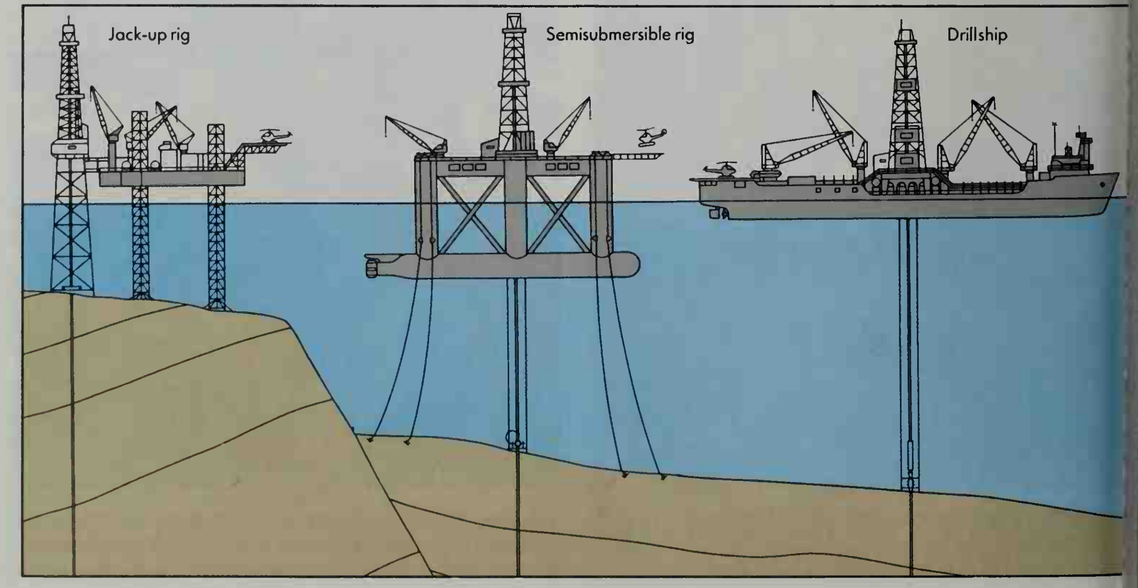
Semisubmersible rigs are used in intermediate water depths—that is, up to 4,000 feet (1,200 meters). This type of rig has legs filled with air, enabling it to float above the surface of the ocean. Anchors hold the rig in place.

Drillships are used in water depths of up to 8,000 feet (2,400 meters). Anchors cannot be used at such depths,

Offshore drilling

Most exploratory offshore wells are drilled from *jack-up rigs, semisubmersible rigs,* or *drillships.* A jack-up rig, which can be raised or lowered to various heights, has legs that rest on the ocean floor. A semisubmersible rig floats on cylindrical legs filled with air. A drillship has drilling equipment mounted on its deck, and a special opening through which the drill pipe is lowered.

WORLD BOOK illustration by Robert Keys



a drillship must use precise navigational procedures to maintain its position above the well site. The derrick and other drilling equipment are mounted on the deck, and the drill pipe is lowered through an opening in the bottom of the ship. Drillships are extremely expensive to operate.

Fixed platforms, also known as *production platforms,* are generally built and installed only after exploratory drilling has uncovered enough petroleum reserves to justify their enormous expense. Most fixed platforms are used in shallow water, but some can be used in water deeper than 1,000 feet (300 meters).

Fixed platforms are built in segments that are carried by barge to the production site. Cranes guide the bottom segment to the ocean floor and position it over the site. Huge stakes called *piles* secure it to the ocean floor. The second segment fits on top of the bottom segment. Most fixed platforms have two segments, but some have three. The top of the uppermost segment serves as the base for the drilling. As many as 42 wells can be drilled in various directions from a fixed platform.

Well testing. Drilling crews try to determine as quickly as possible whether they are working on a productive site or a dry hole. During drilling, they continually examine the cuttings—the pieces of rock brought up by the drilling mud—for evidence of petroleum. When drilling reaches the depth of possible deposits, the crew may conduct several tests for oil. These tests include *coring, logging,* and *drill stem testing.*

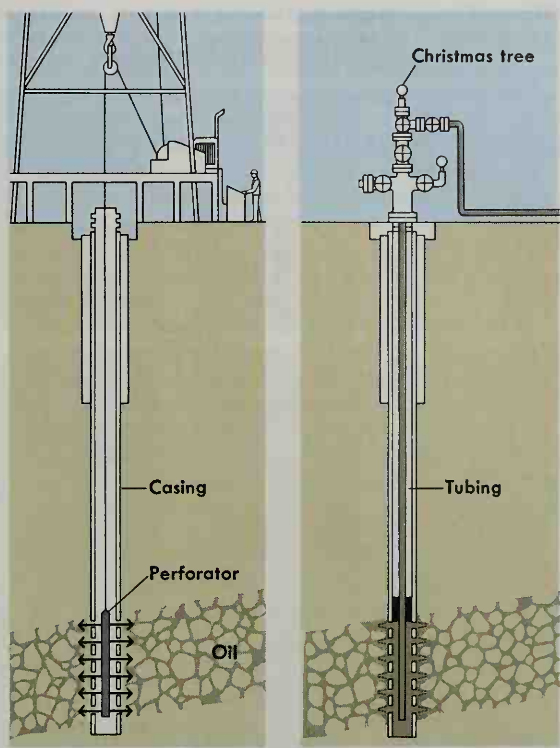
In coring, the drill bit is replaced with a *coring bit.* This bit cuts out a cylindrical sample of soil and rock, which is brought to the surface for analysis. Logging involves lowering measuring instruments called *sondes* into the well hole. They transmit information about the composition, porosity, fluid content, and other characteristics of the underground rock. In the drill stem test, a device that takes samples of fluids and measures their pressure is lowered into the hole.

If the test results are negative, the drilling crew may plug the well with cement and abandon it. If the tests show evidence of petroleum, the crew reinforces the well hole with steel pipe called *casing.*

Casing is a kind of protective lining for the well hole. It consists of heavy steel pipe that ranges in diameter from $2\frac{7}{8}$ to 20 inches (7.3 to 51 centimeters). The lengths of pipe are held in place with cement. Casing helps prevent leaks and cave-ins during both the drilling stage and the production stage of the oil well. As an additional safeguard, nearly all drilling crews install one or more *blowout preventers* at the top of the casing. These devices consist of giant valves that close off the casing if pressure builds up in the well.

To install casing, drilling crews remove the drill pipe and lower the casing into the well hole. They then pump wet cement down the casing and cover the cement with a special plug that can be drilled through. While the cement is still wet, they pump mud into the casing. The mud pushes the plug to the bottom of the casing. The cement is thus forced up into the space between the well hole and the outside of the casing from the bottom of the hole to the surface. After the cement hardens, workers can continue to drill through the plug.

Completing the well means bringing the well into production. This operation is carried out in several



WORLD BOOK illustration by Robert Keys

Completing a well. After lining the well hole with pipes called *casing,* the crew lowers an instrument called a *perforator* into the well. The perforator punches holes in the casing through which oil can enter, *left.* Then the crew installs the *tubing,* a string of smaller pipes that conducts the oil to the surface; and a *Christmas tree,* a set of valves that controls the flow of oil, *right.*

steps. First, the drilling crew lowers an instrument called a *perforator* into the casing to the depth of the oilbearing zone. The perforator fires special bullets or explosive charges into the casing, punching holes through which the oil can enter. The crew then installs the *tubing,* which is a string of smaller pipes that conducts oil to the surface. Tubing is used because the casing is generally too wide to maintain the fluid velocity necessary to keep the oil flowing upward. Tubing is also easier to repair and replace than casing.

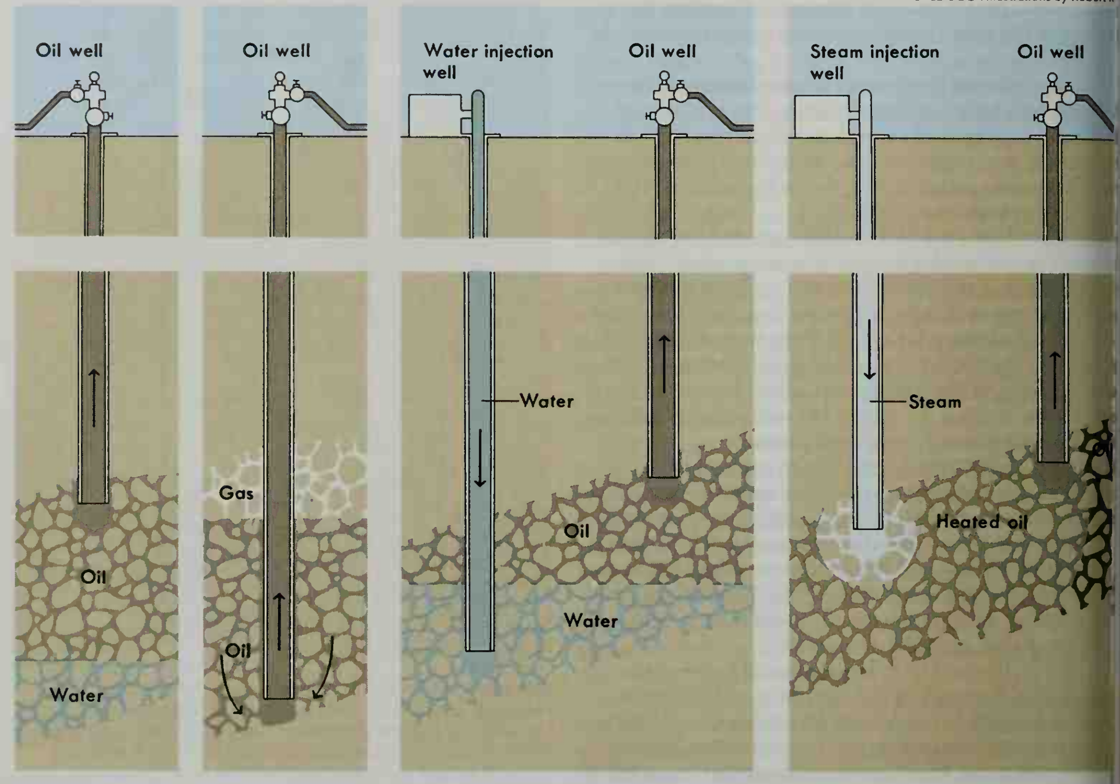
One final step in completing a well is to assemble a group of control valves at the upper end of the casing and tubing. This valve system is known as a *Christmas tree* because of its many branchlike fittings. It controls the flow of oil to the surface. In some wells, more than one oilbearing zone is found. The crew then installs separate tubing and control valves for each zone. Such operations are called *multiple completion wells.*

Recovering petroleum

Petroleum is recovered in much the same way as underground water is obtained. Like certain types of water wells, some oil wells have sufficient natural energy to bring the fluid to the surface. Other oil wells have too little energy to produce oil efficiently, or they lose most of their energy after a period of production. In these wells, additional energy must be supplied by pumps or other artificial means. If natural pressure provides most of the

How oil is recovered A tremendous amount of energy is needed to bring oil to the surface. This energy may come from the natural pressure in a reservoir or from various artificial means. Depending on the source of energy, the process is called (1) primary recovery, (2) secondary recovery, or (3) tertiary recovery.

WORLD BOOK illustrations by Robert K



Primary recovery depends chiefly on two types of natural energy in a reservoir, *water drive* and *gas drive.* If oil production reduces some of the pressure underground, water or gas in the reservoir may drive the oil into the well.

Secondary recovery consists of replacing the natural energy in a reservoir. *Waterflooding,* one of the most widely used methods, involves injecting water into the reservoir. The water displaces the oil and causes it to flow into the well.

Tertiary recovery includes a number experimental methods of bringing oil to the surface. In one such method, steam injected into the reservoir. The steam heats the oil and makes it thinner, enabling it to flow more freely into the we

energy, the recovery of petroleum is called *primary recovery.* If artificial means are used, the process is known as *enhanced recovery.*

Primary recovery. The natural energy used in recovering petroleum comes chiefly from gas and water in reservoir rocks. The gas may be dissolved in the oil or separated at the top of it in the form of a gas cap. Water, which is heavier than oil, collects below the petroleum. Depending on the source, the energy in the reservoir is called (1) solution-gas drive, (2) gas-cap drive, or (3) water drive. Solution-gas drive brings only small amounts of oil to the surface. Most wells that have no natural energy other than solution-gas drive require supplementary forms of energy. Gas-cap drive and water drive, on the other hand, may result in the production of large quantities of petroleum.

Solution-gas drive. The oil in nearly all reservoirs contains dissolved gas. The effect production has on this gas is similar to what happens when a bottle of champagne is opened. The gas expands and moves toward the opening, carrying some of the liquid with it.

Gas-cap drive. In many reservoirs, gas is trapped in a cap above the oil as well as dissolved in it. As oil is produced from the reservoir, the gas cap expands and drives the oil toward the well.

Water drive. Like gas, water in a reservoir is held ir place mainly by underground pressure. If the volume water is sufficiently large, the reduction of pressure th occurs during oil production will cause the water to e pand. The water will then displace the petroleum, forc ing it to flow into the well.

Enhanced recovery includes a variety of methods designed to increase the amount of oil that flows into producing well. Depending on the stage of productio in which they are used, these methods are generally classified as either *secondary recovery* or *tertiary* (thir level) *recovery.*

Secondary recovery, also called *pressure maintenance,* consists of replacing the natural drives in the r ervoir. This form of recovery may involve injecting ga or water into the reservoir from additional wells drille near the producing well.

Although secondary recovery has nearly tripled the amount of recoverable oil, about two-thirds of the petroleum in most reservoirs remains below the surface after production. Petroleum engineers are testing tec

ques of tertiary recovery to bring more oil to the sur-
ce. One such technique uses heat to thin the oil and so
ake it flow more freely into the well. This heat may
me from injections of steam or from burning some of
e petroleum in the reservoir.

Transporting petroleum

After crude oil reaches the surface, natural gas is sep-
ated from the oil. The gas is then sent to a processing
ant or directly to consumers. Water and sediment are
moved from the oil, which is then stored in tanks or
nt to a refinery. From the refinery, petroleum products
e delivered to markets. In the United States, more than
million barrels of petroleum are transported daily. Pe-
oleum is carried chiefly by pipeline, tanker, barge, tank
uck, and railroad tank car.

Most petroleum moves through pipelines for at least
rt of its journey. Pipelines transport crude oil from
ells to storage tanks, to other carriers, or directly to re-
eries. Pipelines also carry petroleum products from
fineries to markets. Some of the largest pipelines can
rry more than a million barrels of oil daily. Pipelines
n be built in almost any kind of terrain and climate.
e Trans-Alaska Pipeline, for example, crosses 3 mountain ranges, more than 300 rivers and streams, and nearly 400 miles (640 kilometers) of frozen land. Pipelines cost much to build. But they are relatively cheap to operate and maintain and are generally the most efficient means of moving petroleum.

Tankers and barges transport oil on water. A tanker is a large oceangoing ship with compartments for liquid cargo. The largest tankers can hold more than a million barrels of petroleum. Tankers haul nearly all the oil imported by the United States. Barges, which can carry an average of 15,000 barrels of oil, are used mainly on rivers and canals.

Many petroleum products travel from refineries to markets by tank truck or railroad tank car. Tank trucks deliver gasoline to service stations and heating oil to houses. Such trucks can carry up to 300 barrels of fuel. Railroad tank cars range in capacity from about 100 to more than 1,500 barrels of oil. Some of these cars have equipment to keep petroleum products at a certain temperature or level of pressure.

Refining petroleum

From a distance, a petroleum refinery may appear to be a lifeless maze of towers, tanks, and pipes. But refin-

w oil is nsported

Petroleum is transported by a variety of methods during its journey from oil field to consumer. Nearly all oil moves through pipelines for at least part of the route. After crude oil is separated from natural gas, pipelines transport the oil to another carrier or directly to a refinery. Petroleum products travel from the refinery to market by tanker, truck, railroad tank car, or pipeline.

WORLD BOOK illustration by Robert Keys

eries hum with activity day and night. They can operate continuously for up to five years before being shut down for repairs. Refineries range in size from small plants that process about 150 barrels of crude oil a day to giant complexes with a daily capacity of more than 600,000 barrels.

The basic job of a refinery is to convert petroleum into useful products. Crude oil consists chiefly of combinations of hydrocarbons, as described in the section of this article called *The uses of petroleum.* Refineries separate the oil into various hydrocarbon groups, or fractions. The fractions are then chemically changed and treated with other substances. These refining processes may be classified as (1) separation, (2) conversion, and (3) chemical treatment.

Separation. The first stage in petroleum refining is *fractional distillation,* which is a process that separates crude oil into some of its fractions. Additional fractions may be separated from these fractions by the processes of *solvent extraction* and *crystallization.*

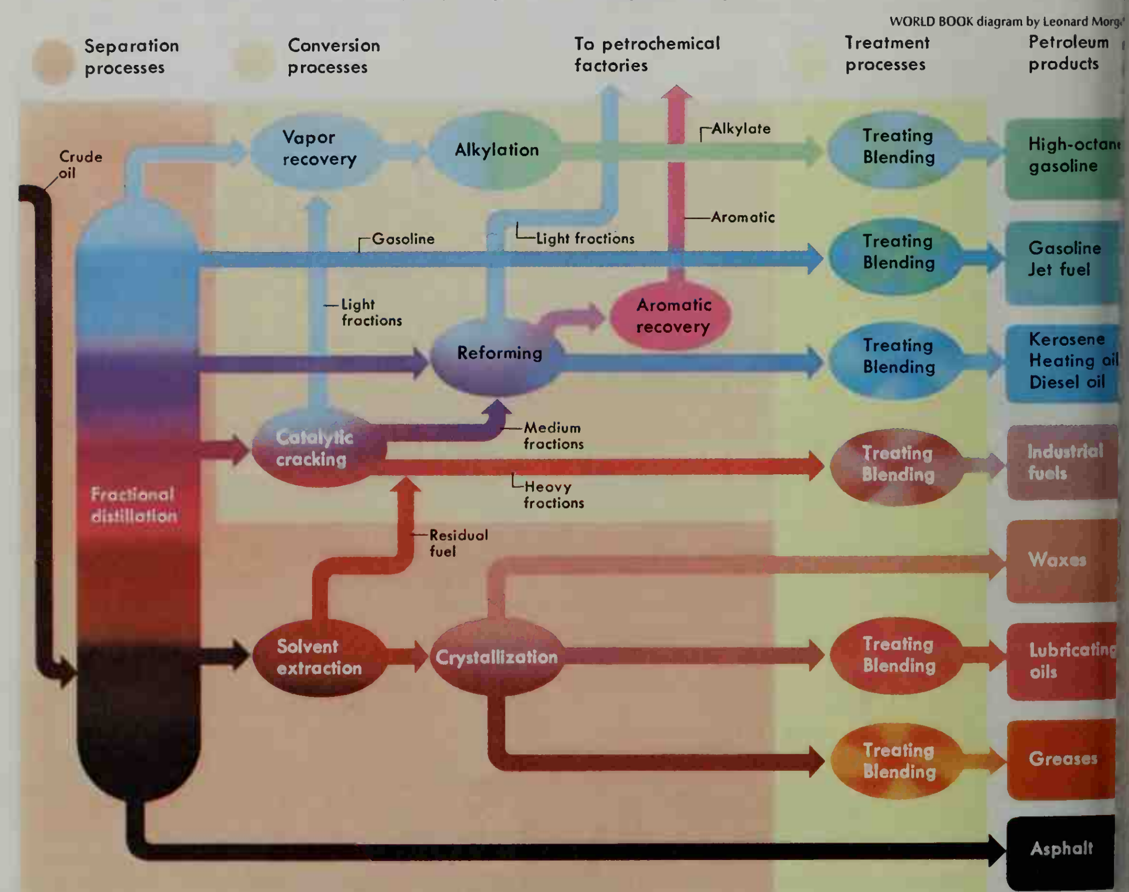
Fractional distillation is based on the principle that different fractions *vaporize* (boil) at different temperatures. For example, gasoline vaporizes at about 75° F. (24° C), but some of the heavy fuel oils have boiling points higher than 600° F. (316° C). As vapors, such fractions also *condense* (cool and become liquid) at different temperatures.

In fractional distillation, crude oil is pumped through pipes inside a furnace and heated to temperatures as high as 725° F. (385° C). The resulting mixture of hot gases and liquids then passes into a vertical steel cylinder called a *fractionating tower* or a *bubble tower.* As the vaporized fractions rise in the tower, they condense at different levels. Heavy fuel oils condense in the lower section of the tower. Such light fractions as gasoline and kerosene condense in the middle and upper sections. The liquids collect in trays and are drawn off by pipes along the sides of the tower.

Some fractions do not cool enough to condense. They pass out of the top of the fractionating tower into a *vapor recovery unit.* Other fractions, which vaporize at temperatures higher than those in the furnace, remain as liquids or semisolids. These *residues* are recovered from the bottom of the tower and refined into such

How oil is refined

Refineries convert crude oil into useful products in three basic stages. The first stage, called *separation,* consists of separating the oil into its various *fractions* (parts). The main process in this stage is *fractional distillation,* which separates light, medium, and heavy fractions. In *conversion,* the second stage, less useful fractions are converted into more valuable ones. The third stage is *treatment,* which improves the quality and performance of petroleum products.



ducts as asphalt and lubricating oils.

Fractions produced by distillation are called *straight-* *products.* Almost all of them must undergo conver- n and chemical treatment before they can be used.

Solvent extraction separates additional fractions from tain straight-run products. A chemical called a *sol-* *nt* either dissolves some of the fractions or causes m to separate out as solids. The principal solvents d include *benzene, furfural,* and *phenol.* Many refin- es improve the quality of kerosene and lubricating by solvent extraction.

Crystallization is used chiefly to remove wax and er semisolid substances from heavy fractions. The ctions are cooled to a temperature at which they form stals or solidify. They are then put through a filter that arates out the solid particles.

Conversion. Although nearly all petroleum can be ned into useful products, some fractions have much re value than others. Gasoline, for example, accounts almost half the petroleum products used in the ted States. But it makes up only about 10 per cent of straight-run products. On the other hand, some frac- ns that are in less demand than gasoline make up a her percentage of crude oil.

To increase the yield of desirable products from pe- leum, scientists have developed several methods to vert less useful fractions into those in greater de- nd. These methods fall into two main groups: (1) cking processes and (2) combining processes. Con- sion processes allow refiners to produce about half a rel of gasoline from each barrel of crude oil.

Cracking processes convert heavy fractions into ter ones, mainly gasoline. These processes not only rease the quantity of gasoline obtained from oil but improve the quality. Gasoline produced by cracking a higher *octane number* than the straight-run prod- Octane number is a measure of how smoothly fuel ns in an engine. See **Octane number.**

There are two principal types of cracking processes— *rmal cracking* and *catalytic cracking.* In thermal cking, heavy fractions are subjected to intense heat pressure in order to weaken the bonds that hold ge, complex molecules together. The heat and pres- e *crack* (break down) these molecules into the sim- r ones that make up light fractions.

n catalytic cracking, a *catalyst* is used to accelerate thermal cracking process. A catalyst is a substance t sets off or speeds up a chemical reaction without ng changed by the reaction. In this form of cracking, fractions are heated and then passed over minerals ed *zeolites,* certain types of clay, or other catalysts. combination of heat and catalytic action causes the vy fractions to crack into lighter ones. Catalytic cking is more widely used than thermal cracking be- se it requires less pressure and produces higher-oc- e gasoline.

During cracking, hydrogen may be added to the frac- s. This procedure, known as *hydrogenation,* further eases the yield of useful products.

Combining processes do the reverse of cracking. y combine or rearrange simple gaseous hydrocar- s to form more complex fractions. As a result, many he gases produced by distillation and cracking are verted into high-octane liquid fuels and valuable chemicals. The major combining processes include *polymerization, alkylation,* and *reforming.*

In polymerization, gases are subjected to heat and pressure in the presence of a catalyst. The hydrocarbon molecules unite and form larger molecules known as *polymers.* Polymers are essential ingredients in high-octane gasoline. Alkylation is similar to polymerization. It produces a fraction called *alkylate,* which is used in both aviation fuel and gasoline. In reforming, the molecules in gases form different hydrocarbon groups after exposure to heat and a catalyst. Reforming produces high-octane fuels and *aromatics,* which are chemicals used in making explosives, synthetic rubber, food preservatives, and many other products.

Chemical treatment. Nearly all fractions are chemically treated before they are sent to consumers. The method of treatment depends on the type of crude oil and on the intended use of the petroleum product.

Many fractions are treated to remove impurities. The most common impurities are sulfur compounds, which can damage machinery and pollute the air when burned. Treatment with hydrogen is a widely used method of removing sulfur compounds. In this method, fractions are mixed with hydrogen, heated, and then exposed to a catalyst. The sulfur in the fractions combines with the hydrogen, forming hydrogen sulfide. The hydrogen sulfide is later removed by a solvent.

Some fractions perform better if they are blended or combined with other substances. For example, refineries blend various lubricating oils to obtain different degrees of *viscosity* (thickness). Gasoline is blended with chemicals called *additives,* which help it burn more smoothly and give it other special properties.

The petroleum industry

The petroleum industry is one of the world's largest industries. It has four major branches. The *production branch* explores for oil and brings it to the surface. The *transportation branch* sends crude oil to refineries and delivers the refined products to consumers. The *manufacturing branch* processes crude oil into useful products. The *marketing branch* sells and distributes the products to consumers. Gasoline service stations handle the largest share of these sales. Oil companies sell their petroleum products directly to factories, power plants, and transportation-related industries.

The petroleum industry plays a large role in the economy of many nations. In such developed countries as the United States and Canada, it provides jobs for a great many people. It also is a major buyer of iron, steel, motor vehicles, and many other products. In certain developing but oil-rich countries, petroleum exports furnish most of the national income. Petroleum is also a source of political power for such countries because many other nations depend on them for fuel.

In the United States, the petroleum industry ranks as one of the largest private employers. The industry includes about 45,000 companies, most of which are small firms that specialize in one branch of the industry. The larger companies are active in all branches. The eight largest oil firms handle about 50 per cent of the petroleum produced, refined, and sold in the United States. In addition to these companies, there are nearly 200,000 gasoline service stations, most of which are independ-

ently owned and operated. The petroleum industry employs about 1 $\frac{1}{2}$ million workers and has an investment of about $330 billion in plants and machinery.

The United States is one of the world's leading producers and refiners of petroleum. About 2 $\frac{1}{2}$ billion barrels of crude oil are produced by U.S. wells annually. Only Saudi Arabia produces more petroleum. About 5 $\frac{1}{2}$ billion barrels of petroleum annually, or about a fourth of the world total, are processed by U.S. refineries. The United States is also the world's largest consumer of petroleum. The nation's demand for crude oil far exceeds domestic production. As a result, the country imports more than 60 percent of the oil it uses.

The price of imported crude oil has risen since the early 1970's, leading the U.S. petroleum industry to look for new ways to increase domestic oil production. The industry is researching methods of oil production in extremely harsh environments, such as the Arctic and underwater depths greater than 6,500 feet (2,000 meters). Researchers are also seeking more efficient techniques for recovering petroleum and for converting coal, oil shale, bituminous sands, and other plentiful hydrocarbons into synthetic oil and gas. In addition, researchers are studying such alternative sources of energy as the sun, wind, and internal heat of the earth.

In Canada, the petroleum industry is owned and run largely by private companies. In 1975, a government corporation called Petro-Canada became involved in exploring for new reserves and in developing synthetic forms of oil. Legislation passed in 1991, however, allows Petro-Canada to sell stock, changing its status to that of a publicly held corporation. The government also participates in the petroleum industry through its power to grant mineral leases to oil companies.

The petroleum industry in Canada began to expand rapidly in 1947, when prospectors made a great oil strike in Leduc, Alberta. Annual production jumped from about 8 million barrels of oil in that year to a peak of about 650 million barrels in the mid-1970's. Canada was a leading exporter of oil to the United States until 1975. Since then, Canada's reserves and production have declined, and it has reduced oil exports to the United States. Canada produces about 800 million barrels of oil annually. The nation's refineries process more than 600 million barrels annually, which makes Canada one of the world's leading refiners.

More than 1,500 Canadian companies produce petroleum. However, the 20 largest firms account for about 80 percent of Canada's oil production. More than 60,000 people work in the production and manufacturing branches of the oil industry, and many others have jobs in the transportation and marketing branches.

In other countries. During the early 1900's, foreign oil companies began to develop the petroleum industry in various countries in the Middle East, Africa, and other parts of the world. These firms, most of which were American or European, received ownership of the oil they discovered and produced. In return, they paid the host countries taxes and a share of the income from oil sales. Beginning in the 1950's, however, more and more host countries came to feel that they were not receiving a large enough share of the oil income. Today, many of these countries have acquired part or total control of the oil industry within their borders, either by negotiating with the foreign firms or by taking them over. A number of the countries belong to the powerful Organization of Petroleum Exporting Countries (OPEC).

OPEC, which was formed in 1960, consists of a group of nations that depend heavily on oil exports for their income. These nations include Libya, Nigeria, Venezuela, and the major oil-producing countries of the Middle East. OPEC members provide about 45 percent of all oil exports. Thus, the amount they produce and the prices they agree to charge largely determine the cost of petroleum. Industrialized countries are so dependent on imported oil that OPEC can use oil as an economic and political weapon. In the 1970's, OPEC raised oil prices so drastically that its members were able to increase their income from oil while restricting production.

Petroleum conservation

The world's supply of oil is limited and will eventually run out. Some experts predict that if oil consumption continues to rise, existing petroleum reserves will be exhausted by the early 2000's. Conservation of oil has thus become urgent for all nations, but particularly for those

Leading petroleum-producing countries

Barrels of petroleum produced in a year*

Country	Barrels
Saudi Arabia	3,067,460,000 barrels
Russia	2,364,835,000 barrels
United States	2,125,030,000 barrels
Iran	1,357,435,000 barrels
China	1,185,885,000 barrels
Norway	1,166,905,000 barrels

*One barrel equals 42 gallons (159 liters).
Figures are for 2000.
Source: U. S. Energy Information Administration.

Leading petroleum-producing states and provinces

Barrels of petroleum produced in a year*

State/Province	Barrels
Alberta	562,900,000 barrels
Texas	443,396,000 barrels
Alaska	355,198,000 barrels
California	271,132,000 barrels
Saskatchewan	135,011,000 barrels
Louisiana	105,424,000 barrels

*One barrel equals 42 gallons (159 liters).
State figures are for 2000; province figures are for 1999.
Sources: U. S. Energy Information Administration; Natural Resources Canada.

at use the most energy. It is estimated that the United ates, which consumes about 25 per cent of the oil pro- ıced in the world, could reduce its energy needs by ılf through an active program of conservation.

There are almost as many ways to conserve petro- um as there are to use its products. The oil industry ıs adopted measures to maximize production and re- ıce waste at oil fields and refineries. Some measures ıve become law in the United States, Canada, and her countries. For consumers, conservation includes ıveling less by car, lowering furnace thermostat set- ıgs in winter, and raising air-conditioning thermostat ttings in summer. Consumer conservation measures ve become law in numerous nations.

Conservation by the oil industry. Most of the oil- oducing states in the United States and most such ovinces in Canada have commissions that regulate oil mpanies. One function of these regulatory commis- ons is to ensure that oil companies recover petroleum ficiently. A commission may therefore restrict the mber of wells drilled in an area and the rate at which ells are made to produce. Without such restrictions, e natural drives in oil fields would soon be exhausted, d much oil might be wasted.

The oil industry itself has developed a number of ethods of conservation. Most of them are classed as (1) -field conservation or (2) refinery conservation.

Oil-field conservation consists chiefly of methods to crease the amount of petroleum recovered. One of the ost widely used measures of oil-field conservation is a oling system called *unitization*. Under this system, o or more oil companies working in the same field ree to operate as a unit. Unitization enables the com- nies to make the most efficient use of natural and arti- ial energy in recovering oil.

Refinery conservation is aimed mainly at reducing e amount of heat energy used in refining. Most refin- es have devices called *heat exchangers,* which recy- e excess heat from such processes as fractional distil- ion and thermal cracking. New catalysts are being veloped to lower the energy requirements of the emical reactions. Many plants use computers to main- n furnaces and heaters at the most efficient tempera- es. Heat energy is also conserved by insulating pipes, ks, and other refinery equipment.

Conservation by consumers. Some of the most ex- sive conservation programs have been adopted by mmercial consumers of petroleum. Many manufactur- have installed equipment to store energy and re- ce fuel consumption in their plants. Such materials as minum and paper are reused in some factories be- se recycling waste products requires less energy n manufacturing new products.

Certain conservation measures originally adopted by ne businesses and factories are now legally enforced. he United States, for example, temperatures in most rk areas cannot be cooled below 78° F. (26° C) in sum- r nor heated above 65° F. (18° C) in winter. American l Canadian automobile manufacturers are required law to produce fuel-efficient cars.

n the home, common sense is often the best guide to ing energy. In cold months, for example, people can e advantage of solar energy simply by opening their tains during the day. They can further reduce fuel consumption by closing the curtains at night and by turning off the heat in rooms that are not being used. Homeowners who live in cold climates can conserve heat by installing storm windows, weather stripping, and other forms of insulation.

Most consumers can also conserve on fuel that they use outside the home. By keeping automobiles well tuned and by driving within speed limits, motorists can minimize gasoline consumption. They can save even more fuel by purchasing fuel-efficient cars, forming car pools, or switching to public transportation.

History of the use of petroleum

People have used petroleum for thousands of years. The Bible mentions that Noah used a solid form of petroleum called *pitch* in building the Ark. The ancient Egyptians coated mummies with pitch. About 600 B.C., King Nebuchadnezzar II used pitch to build the walls and pave the streets of Babylon.

In America, the Indians used crude oil for fuel and medicine hundreds of years before the first white settlers arrived. In the early 1600's, missionaries traveling through what is now Pennsylvania found Indians scooping up oil from surface pools. The remains of wells in the Eastern United States indicate that the Indians also obtained oil from underground deposits.

By 1750, the American colonists had found many oil seepages in New York, Pennsylvania, and what is now West Virginia. Some wells that were dug for salt produced oil. Salt makers regarded the oil as a nuisance, but other people found uses for it. About 1857, Samuel M. Kier, a Pittsburgh pharmacist, promoted oil as a cure for many ailments. The frontiersman Kit Carson sold oil as axle grease to pioneers.

A major breakthrough in the use of petroleum occurred in the 1840's, when a Canadian geologist named Abraham Gesner discovered kerosene. This fuel could be distilled from coal or oil. Kerosene became widely used for lighting lamps, and oil quickly rose in value.

Beginnings of the oil industry. Most historians trace the start of the oil industry on a large scale to 1859. That year, a retired railroad conductor named Edwin L. Drake drilled a well near Titusville, Pa. Drake used an old steam engine to power the drill. After Drake's well began to produce oil, other prospectors drilled wells nearby. Within three years, so much oil was being produced in the area that the price of a barrel dropped from $20 to 10 cents.

By the early 1860's, the oil boom had transformed western Pennsylvania. Forests of wooden derricks covered the hills, and thousands of prospectors crowded into the new boom towns. At first, wagons and river barges carried the oil to refineries on the Atlantic Coast. But the growing volume of oil soon required more efficient means of transportation. Railroads established branch lines to the fields and began to haul oil. In 1865, the first successful oil pipeline was built from an oil field near Titusville to a railroad station 5 miles (8 kilometers) away. Within 10 years, a 60-mile (97-kilometer) line ran from the oil region to Pittsburgh.

Prospectors discovered that other states had even larger oil deposits than Pennsylvania. By the 1880's, commercial production of oil had begun in Kentucky, Ohio, Illinois, and Indiana. In 1901, the opening of the Spindle-

top field in eastern Texas produced the first gusher in North America. During the 1890's and early 1900's, California and Oklahoma joined Texas as the leading oil-producing states. Annual U.S. oil production rose from 2,000 barrels in 1859 to 64 million barrels in 1900.

Commercial oil production spread rapidly throughout the world. Italy began to produce oil in 1860. After Italy, production began, in order, in Canada, Poland, Peru, Germany, Russia, Venezuela, India, Indonesia, Japan, Trinidad, Mexico, and Argentina. The first important oil discoveries in the Middle East occurred in Iran in 1908. Prospectors struck oil in Iraq in 1927 and in Saudi Arabia in 1938. Huge oil fields were later found in other states on the Persian Gulf.

Growth of the oil industry. During the 1800's, kerosene had been the chief product of the petroleum industry. Refiners considered gasoline a useless by-product and often dumped it into creeks and rivers. Then, about 1900, two events dramatically changed the situation—electric lights began to replace kerosene lamps, and the automobile rolled onto the American scene. The demand for kerosene thus declined just as an enormous market for gasoline opened up.

At that time, however, 100 barrels of crude oil produced only about 11 barrels of gasoline. As a result, petroleum refiners needed to increase the output of gasoline. The introduction of the thermal-cracking process in 1913 helped solve the problem. Within five years, refiners had more than doubled the amount of gasoline that they could produce from a barrel of crude oil.

American Petroleum Institute

The first gusher in North America blew in at the Spindletop field near Beaumont, Tex., in 1901. It sprayed more than 800,000 barrels of oil into the air until it was brought under control.

World War I (1914-1918) created a tremendous demand for petroleum fuels to power ships and airplanes. Fuels became as important as ammunition. After the war, the use of petroleum brought about big changes on farms. More and more farmers began to operate tractors and other equipment powered by oil. Agricultural productivity increased greatly as a result. In addition, gasoline taxes provided the money and asphalt furnished the raw material to build roads in rural areas. Farmers thereby gained better access to markets.

During World War II (1939-1945), the American oil industry proved its ability to increase production and develop specialized products quickly. Huge quantities of oil were produced and converted into fuels and lubricants. Such new refining processes as catalytic cracking and alkylation vastly increased the output of high-octane aviation gasoline. The United States supplied over 80 per cent of the aviation gasoline used by the Allies during the war. American refineries also manufactured *butadiene,* used in making synthetic rubber; *toluene,* an ingredient in TNT; medicinal oils to treat the wounded; and many other military necessities.

Postwar developments. The demand for petroleum products became even greater after World War II. The petroleum used in the United States climbed from abou $1\frac{3}{4}$ billion barrels in 1946 to almost $2\frac{1}{2}$ billion barrels in 1950. By the early 1950's, petroleum had replaced coal as the country's chief fuel. Some of the petroleum technology perfected during the war became the basis for peacetime industry. The petrochemical industry, for example, grew enormously as a result of the manufacture of synthetic rubber.

The United States was not alone in its rising level of petroleum consumption. Throughout the world, increased industrialization and rapid population growth created new and greater demands for oil. Control over the sources and transportation of oil soon became a vital issue in national and international politics.

In the United States, the issue of control over oil centered on the offshore deposits of Louisiana, Texas, and other states. These states claimed ownership of the *tide lands* (offshore areas within their traditional boundaries The federal government, however, insisted that the tide lands belonged to the nation. The dispute delayed the development of new offshore wells because oil companies did not know whether the states or the federal government owned the territory. Finally, in 1953, Congress passed an act that granted jurisdiction of the tidelands to the states and so enabled them to lease offshore sites to oil companies. In 1975, the Supreme Court limited the tidelands of most states to areas within 3 nautical miles (5.6 kilometers) of their coastline.

On the international scene, the struggle for oil focused on the Middle East, which has more than half of the world's petroleum reserves. The petroleum industry in many Middle Eastern countries was owned or operated by American or European companies. In 1951, Iran became the first country to take over the holdings of such firms. By the mid-1970's, most nations in the Middle East either fully controlled or held a majority interest in their petroleum industry.

Recent developments. The ever-increasing use of petroleum products, especially in developed countries,

ias helped raise the living standards of many people. 3ut it has also resulted in some serious problems, which nclude (1) the energy shortage, (2) the fluctuating price of oil, and (3) environmental pollution. It may also contribute to a process known as *global warming.*

The energy shortage. During the 1960's, prospectors liscovered significant amounts of oil in northern Alaska nd in the North Sea. But these gains were offset by rising levels of consumption in many industrialized naions, including Japan, the United States, and Western uropean countries. During the late 1960's and early 970's, political instability in the Middle East disrupted he flow of oil to Japan and some Western nations. In the 970's, the member countries of OPEC, who held the najority of the world's remaining oil reserves, realized hey could control the price of oil if they acted in unison. \s a result, OPEC increased the price of oil. The price of barrel of crude oil jumped from about $2.75 in 1973 to peak of $34 in 1981.

Due to the increasing price, many countries began nergy-conservation programs. In addition, oil and gas xploration increased throughout the world. In the Unitd States, companies redrilled many wells that had been onsidered insufficiently productive or not profitable nough. Consequently, the price dropped back to 12.50 in 1984. Since then, the price has fluctuated beween about $10 and $35 per barrel.

The fluctuating price of oil. Many economists agree hat it is difficult to predict future oil prices. When prices all, there is little incentive for consumers to conserve nergy or for companies to explore for new oil and gas eserves. Prices continue to drop until a shortage develps in the amount of oil that is immediately available for se. At this point, prices rise and exploration intensifies. lowever, it can often take as long as 10 years from the rst day of exploration for oil production to begin, espeially in offshore wells. During the waiting period, little r no new production occurs, and so the shortage eepens and prices continue to increase.

Environmental pollution. The production, transportaon, and use of petroleum have created problems of enironmental pollution. Tankers and offshore drilling acidents can cause oil spills that pollute the water, lamage beaches, and destroy wildlife.

The burning of *fossil fuels* (coal, oil, and gas) by motor ehicles, power plants, and factories is the chief source f air pollution in most cities. Many laws have been assed throughout the world to control pollution. The etroleum industry has invested heavily in the developnent of techniques and products to minimize pollution. o reduce the pollutants in automobile exhaust, for exmple, oil companies cooperated with car manufacturrs in the production of unleaded gasoline. But rising vels of oil consumption have offset some of the gains gainst pollution.

Global warming is an increase in the average temperure of the earth's surface. Since the late 1800's, the avrage temperature has increased about 0.5 to 1.5 ahrenheit degrees (0.3 to 0.8 Celsius degree). The burnig of fossil fuels may contribute to global warming by dding carbon dioxide gas to the earth's atmosphere. ossil fuels produce this gas when they burn. The added irbon dioxide would contribute to global warming by nhancing the *greenhouse effect.* This effect warms the earth's lower atmosphere and surface through a complex process involving sunlight and atmospheric gases and particles.

The future of the petroleum industry. Most experts predict that the worldwide demand for petroleum will continue to increase in the years ahead. They also predict that the world's dependence on oil from the Middle East will increase. In addition, most experts believe that oil will become scarce sometime in the mid-2000's unless large new deposits are found or alternate energy sources are discovered.

The only long-range solution to the energy problem is the introduction of alternative sources of energy. Scientists have developed techniques to convert coal into oil and gas, and to produce oil from bituminous sands and oil shale. However, these processes are expensive, and many of them have environmental problems of their own. But if oil prices continue to increase, alternative sources eventually may be able to compete in cost with petroleum.

It will probably be many years before alternative fuel sources make a major contribution to the world's energy supply. Until then, oil companies and oil consumers will need to conserve existing reserves by using energy as efficiently and sparingly as possible.

Career opportunities

The petroleum industry employs many kinds of workers, from unskilled laborers to highly trained scientists and engineers. Information on careers in the industry can be obtained from the American Petroleum Institute in Washington, D.C.

Scientists and engineers play a vital role in the petroleum industry. Geologists and geophysicists explore for oil. Other scientists, such as biologists and ecologists, study the environmental effects of the industry's operations. Petroleum engineers supervise well drilling and oil recovery. Oil companies also employ chemical, civil, electrical, and mechanical engineers. All these jobs require college training.

Oil-field workers include derrick workers, drillers, roughnecks, and *roustabouts* (production workers). These workers must have good physical coordination as well as mechanical ability.

Machinists and maintenance workers include mechanics, welders, and electricians. Such jobs require good mechanical judgment and the ability to do precision work.

Control workers and equipment operators keep petroleum flowing efficiently through the various stages of production and refining. These workers read and maintain gauges, meters, and other instruments in oil fields, in refineries, and along pipelines. In addition, these workers check all equipment to see that it runs properly. As computers take over many of these operations, oil companies are hiring increasing numbers of computer maintenance specialists who must have special training.

Marketing workers sell petroleum products and services. They include service station attendants, people who sell petrochemicals to manufacturers, and *jobbers* (individuals who buy from producers and sell to retail dealers). Marketing jobs require business judgment and personal qualities to attract and retain customers.

Clerical and administrative workers handle the business operations of the petroleum industry. Clerical jobs may require training in such subjects as bookkeeping and the operation of office machines. Most administrative jobs require college training in engineering, geology, or geophysics. Robert C. Laudon

Related articles in *World Book.* See the *Economy* section of the articles on the states, provinces, and countries mentioned in the *Where petroleum is found* section of this article. See also:

Products

Asphalt
Butane and propane
Fuel
Gas (fuel)
Gasoline
Kerosene
Mineral oil
Napalm
Naphtha
Paraffin
Petrochemicals
Petrolatum
Petroleum coke
Plastics
Wax (Mineral wax)

Other related articles

Arabs (Economy)
Automobile
Bituminous sands
BP Amoco
Conservation
Distillation
Energy supply
Environmental pollution
Exxon Mobil Corporation
Global warming
Greenhouse effect
Hydrocarbon
Hydrogenation
International Energy Agency
Magnetometer
Ocean (The importance of the ocean; Ocean pollution)
Octane number
Oil shale
Organization of the Petroleum Exporting Countries
Persian Gulf War
Pipeline
Rock
Royal Dutch/Shell Group
Ship (Tankers)
Standard Oil Company
Synthetic fuel

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   A. Petroleum as a fuel
   B. Petroleum as a raw material
   C. Other uses of petroleum
II. **Where petroleum is found**
   A. The Middle East
   B. Europe
   C. Latin America
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   F. The United States and Canada
III. **How petroleum was formed**
IV. **Exploring for petroleum**
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   B. Geophysical studies
V. **Drilling an oil well**
   A. Preparatory measures
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Questions

How can consumers conserve petroleum?
How much oil can be recovered from most deposits?
Which area of the world has the most oil?
What does petroleum consist of?
How do most scientists think oil and gas were formed?
What part did the automobile play in the development of the petroleum industry?
Why do oil crews sometimes inject water or gas into a producing well?
Why is drilling for oil usually an enormous gamble?
Why is offshore drilling for oil more expensive and dangerous than drilling on land?
What is OPEC?

Additional resources

Level I

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Level II

Burger, Joanna. *Oil Spills.* Rutgers, 1997.
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Petroleum coke is a useful product obtained in refining crude oil. The production of petroleum coke begins after all the gasoline, kerosene, gas oils, lubricating oils, and other products have been distilled from crude oil. Pumps then force the heavy *residual oil* that remains through tubes of a furnace. There, the oil is heated to a high temperature. The heated oil stews in *coking drums* until it becomes solid coke. The coke is then treated to remove impurities, especially sulfur. Petroleum coke has many uses in industry. For example, it is used in making carbon or graphite electrodes for flashlight batteries and dry cells. Coke is also important in the refining of various metals and in the production of abrasives and heat-resisting materials. It is used in producing synthetic graphite for nuclear reactors. Carbon made from coke is used in the chemical industry for its resistance to chemicals. W. Simon Tortike

Petroleum jelly. See Petrolatum.

Petroleum wax. See Wax (Mineral wax).

Petrology, *pih TRAHL uh jee,* is a branch of geology that deals with the origin and composition of rocks. Petrologists analyze the physical and chemical conditions involved in the formation of the three major types of rocks: *igneous, metamorphic,* and *sedimentary* (see **Rock**). Such analysis helps provide clues to the origin and development of the earth.

Petrologists work both in the field and in the laboratory. They study the location, position, and distribution of rocks in nature. They use microscopic and chemical techniques to determine the minerals that make up individual rocks. In addition, petrologists attempt to reproduce in a laboratory the temperature and pressure that affect rock formations. These experiments provide data about the physical and chemical properties of rocks under varying conditions. Maria Luisa Crawford

See also **Earth** (Earth's rocks); **Geology** (table).

Petronas Towers, in Kuala Lumpur, Malaysia, are the tallest buildings in the world. Spires atop the 88-story towers bring their structural height to 1,483 feet (452 meters). A double-decker bridge joins the two buildings at the 41st and 42nd stories. The towers are the headquarters of Petronas, also known as Petroliam Nasional

erhad, Malaysia's national oil and gas company.

The Petronas Towers are designed to reflect Islamic rchitecture. The towers are constructed primarily of eel, concrete, and glass. The floor space of the two uildings totals about 4,600,000 square feet (427,000 quare meters).

The Petronas Towers were built by two international roups of construction and engineering firms. Construc-on began in 1993 and was completed in 1998. The ructures were designed by Cesar Pelli & Associates, an rchitectural firm in the United States.

Critically reviewed by Cesar Pelli & Associates

See also **Malaysia** (picture); **Skyscraper**.

etronius, *pih TROH nee uhs* (?-A.D. 66), wrote the rst Roman novel, the *Satyricon*. Only sections of the ovel exist today. The work traces the adventures of iree Romans traveling in Italy. Through a mixture of rose and poetry, Petronius portrayed conditions of real e under the Roman emperor Nero. He described a so-ety filled with dishonesty, insincerity, and vice. Nearly ne-third of the surviving novel deals with a rich but un-ducated man called Trimalchio and a lavish dinner par- that he gave. During the dinner, Trimalchio attempts impress his guests with what he thinks is good taste. owever, the host's showiness and vulgarity expose his iltural inferiority to his intellectually superior guests. A umber of scholars believe that Petronius wrote the ovel to ridicule Roman society under Nero.

Joseph R. Tebben

etty, Richard (1937-), became one of the great-st and most popular drivers in American automobile cing history. Petty specialized in driving stock cars—dinary sedans whose engine and structure have been tered to provide more power and speed. Petty holds most every record of the National Association for ock Car Auto Racing (NASCAR). He started more races 185) and won more races (200) than any other stock r driver. He won the Winston Cup NASCAR national cing championship seven times, a record he holds ith Dale Earnhardt. Petty retired as a driver in 1992.

Petty was born outside Level Cross, North Carolina, ear Randleman. He began to compete in NASCAR ces in 1958. He was nicknamed "King Richard" because his achievements and his popularity. His father, Lee tty, was a noted pioneer stock car racer.

Sylvia Wilkinson

etunia, *puh TOO nee uh,* is the name of a group of ants known for their beautiful, funnel-shaped flowers. tunias rank as one of the most popular garden flowers the United States and many other countries.

A petunia's flowers grow 4 inches (10 centimeters) or ore across. They may be pink, rose, salmon, red, hite, blue, or a mixture of colors. Some varieties have a igle set of petals. Others have a double set.

There are about 30 *species* (kinds) of petunias. Tiny irs cover the stems and leaves of most cultivated petu-as, but some wild species have almost no hairs. Most tunias are *perennials*—that is, they live at least three ars. However, gardeners usually raise the plants as *an-als* (flowers that live one year or less) because they wer during their first year. People may grow petunias m cuttings or from seeds.

Gardeners normally grow petunias in prepared ound beds or in window boxes. Some plant the flowers in hanging baskets. The plants thrive in sunny locations. Their flowers bloom in summer and early fall.

Petunias originated in Argentina, Bolivia, Brazil, Paraguay, and Uruguay. Europeans first brought them from South America to Europe in the 1820's. Gardeners in Europe developed the first cultivated petunias later in the 1800's. Roy E. Gereau

Scientific classification. Petunias belong to the nightshade family, Solanaceae. They make up the genus *Petunia*. The scientific name for cultivated petunias is *P. hybrida*.

Pevsner, *PEHVZ nuhr,* **Antoine,** *ahn TWAHN* (1886-1962), was a Russian-born painter and sculptor. He was the older brother of the sculptor Naum Gabo. Pevsner is associated with a Soviet art movement of the 1920's called Constructivism. He was influenced by Cubist painters and by the sculptor Alexander Archipenko, whom he met in Paris in 1911.



Brass and bronze sculpture (1942), 20 3/4 inches (52.7 centimeters) high; The Museum of Modern Art, New York City

Pevsner's ***Developable Column*** **shows how he tried to enclose space through the creation of a complex series of hollows.**

Pevsner painted until 1923, when he turned to sculpture, perhaps because of the influence of his brother. One of Pevsner's best-known early sculptures is a 1926 portrait of artist Marcel Duchamp made of blades of metal and transparent plastic. In his later work, Pevsner formed bronze, brass, and copper constructions with deep hollows that unite light and space.

Pevsner was born in Orel, Russia. He settled permanently in Paris in 1923. Joseph F. Lamb

See also **Gabo, Naum; Archipenko, Alexander.**

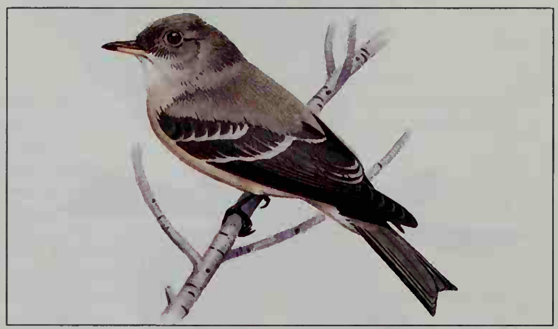
Pew Charitable Trusts donate money to nonprofit organizations that promote the public welfare. The trusts consist of seven individual funds established by the sons and daughters of Joseph N. Pew, founder of the Sun Oil Company (now Sun Company, Inc.). The combined value of the trusts makes them one of the 10 wealthiest foundations in the United States. For assets, see **Foundation** (table). Grants are awarded in the areas of culture, education, health and human services, public

policy, religion, and conservation and the environment. The trusts are headquartered in Philadelphia.

Critically reviewed by the Pew Charitable Trusts

Pewee is the name of 11 species of small birds that are native to the Western Hemisphere. They belong to a family of birds called *flycatchers* (see **Flycatcher**). Pewees are about 6 to 8 inches (15 to 20 centimeters) long. They have gray-brown to greenish-gray backs and pale gray breasts. Most pewees have two white bars on their wings.

Pewees range from southern Alaska and southern and eastern Canada to Argentina. The best-known species in the United States are the *western wood-pewee,* also called the *western pewee,* and the eastern *wood-pewee,* also known as the *eastern pewee.* The western wood-pewee lives in woodlands from southern Alaska and western Canada to Central America. The eastern wood-pewee inhabits forests from southeastern Canada to Florida and Texas. The name *pewee* comes from the eastern wood-pewee's call, which sounds like *pee-a-wee.* Both species breed in the United States and Canada and migrate to Central and South America for the winter. They return to their nesting grounds in April or May. The birds sing at the first sign of daybreak and throughout the day into early evening.



WORLD BOOK illustration by Trevor Boyer, Linden Artists Ltd.

The eastern wood-pewee sings throughout the day.

Eastern and western wood-pewees build nests out of plant fibers. They cover the outside of the nest with lichens or leaves to camouflage it. Female pewees lay two to four eggs that are white with brown speckles on the larger end. The eggs hatch in about 12 days. Pewees eat chiefly ants, flies, bees, and beetles.

Fred J. Alsop III

Scientific classification. Pewees belong to the flycatcher family, Tyrannidae. The scientific name for the western wood-pewee is *Contopus sordidulus.* The eastern wood-pewee is *C. virens.*

Pewter, *PYOO tuhr,* is an alloy that consists mainly of tin. It also contains antimony and copper. Pewter has a metallic, white color much like that of silver and a finish that can vary from dull to highly polished. It is widely used in making such articles as bowls, candlesticks, and tea services. Pewter is a soft alloy and dents easily. Articles made of pewter require care in handling.

Pewter consists of at least 90 percent tin, a very soft metal. From 2 to 8 percent antimony and up to 3 percent copper are added to harden and strengthen pewter. At one time, most pewter also contained lead. But lead caused tarnishing. It also could dissolve in some foods and beverages served in pewterware, forming toxic substances. During the mid-1700's, a nonlead pe-ter called *Britannia metal* came into use in England. It consisted of tin, antimony, and copper and did not ta nish. Today, Britannia metal and pewter are both use make pewter articles.



WORLD BOOK photo by Ralph B

Pewter is an alloy that has a white, metallic color resembling ver. Pewter is used to make bowls and tea services.

How pewter is made. The first step in making pe ter is to melt the tin in a pot called a *crucible.* Next, an mony and copper are dissolved in the liquid tin. Once mixed thoroughly, the alloy is poured into metal, plas or wooden forms to cast the desired articles.

Pewter can also be poured into iron molds and the rolled and cut into standard shapes. Such shapes include disks, rectangular sheets, and wires, which craf workers form into various objects. Pewter disks are shaped by a process called *spinning.* Spinning consis of holding the disk against a steel or wooden form turned by a machine called a *lathe.* Craftworkers use blunt tools to push the pewter into the shape of the spinning form.

Pewter sheets can be shaped into various items by hammering the metal with a leather, metal, plastic, or wooden mallet. Craftworkers use pewter wires as de rative trim for pewter articles. The parts of many pew items are joined by a process called *soldering* (see **S der**).

Caring for pewter. Pewter, if given proper care, does not tarnish or require polishing. It should be washed in hot, soapy water as soon as possible after ing used. Pewter should be rinsed in clear hot water dried immediately with a soft cloth. Pewter articles should not be left to dry in the air. Air drying sometim leaves water spots, which are difficult to remove. Pew should never be washed in a dishwasher because the heat of the drying cycle can darken the surface.

Pewter serving pieces should not be used in prepa ing food. Pewter has a melting point between 471 °F (244 °C) and 563 °F (295 °C), and so it can melt if placed an oven or on a burner.

History. Pewter ranks as one of the oldest known al-oys and may have been used as early as 1500 B.C. From he A.D. 1300's to the 1800's, people in England and the est of Europe used pewter household utensils exten-sively. Pewter became popular with people who could not afford gold and silver serving pieces.

Most of the early pewter used by the American colo-nists was imported from England. In 1635, an English-nan named Richard Graves opened the first pewter shop in the American Colonies. His shop was in Salem n the Massachusetts Bay Colony. The colonists used nany pewter articles, but few such items made by colo-nial craftworkers still exist. Tin had to be imported from England, and the English placed a high tax on it. Thus, he colonists had their old or damaged pewterware nelted and recast into new objects. In the mid-1800's, china and glassware gradually replaced pewter.

Today, most antique pewter is in museums or private collections. Such pewter may contain lead, and so it should not be used for serving food. Making objects out of pewter is a popular craft. Paul E. Davis

Pfiesteria, *fees TEER ee uh,* species are harmful aquat-ic organisms found in coastal regions of the eastern United States. They are a kind of *dinoflagellate,* a group of single-celled organisms that swim by means of two hairlike structures called *flagella. Pfiesteria* exists in as many as 24 different plant or animal-like forms. They usually live buried in sediment in a harmless form called a *cyst.* They can also change into a harmful mobile form.

Pfiesteria changes into a mobile form when fish swim nearby. The tiny organisms then excrete powerful *toxins* (poisons) into the water. The toxins weaken the fish, making them swim slowly and allowing disease-causing bacteria and fungi to eat away at their skin. Eventually, the toxins paralyze and kill the fish. Entire schools of fish can be killed by swimming into waters where *Pfiesteria* is active. Dead and dying fish float on the surface, often covered with large bloody sores, following such an at-tack. *Pfiesteria* feeds on the dead fish.

Human beings and other animals can be harmed by exposure to water that contains *Pfiesteria* toxins. People exposed to the toxins can suffer skin sores, nausea, res-piratory problems, fatigue, and temporary memory loss.

Pfiesteria was first discovered in 1991 after millions of fish were found killed in waters off North Carolina. Sci-entists think that pollution, especially fertilizer runoff, sewage, and animal wastes from farms near coastal wa-ters, has caused more frequent *Pfiesteria* outbreaks.

JoAnn M. Burkholder

Scientific classification. *Pfiesteria* are in the kingdom Pro-tista. Two species are *Pfiesteria piscicida* and *P. shumwayae.*

pH is a number used by scientists to indicate the con-centration of hydrogen ions in a solution. pH generally ranges from 0 to 14. The letters *pH* stand for *potential hydrogen.* At 77 °F (25 °C), a pH below 7 indicates that a solution is acidic, and a pH above 7 indicates that a solu-tion is *basic* (alkaline). A *neutral* solution, such as pure water, is neither acidic nor basic and has a pH of 7. Hu-man blood has a pH of about 7.4.

The Danish biochemist Søren Sørensen invented the pH system in 1909. A solution's pH is defined as the neg-ative logarithm, to the base 10, of its hydrogen-ion con-centration. This concentration is expressed in *moles* of hydrogen ions per liter of solution (see **Mole**). A solu-tion with a pH of 6 contains 10^{-6} (one millionth) of a mole of hydrogen ions per liter.

pH is often measured with an electronic *pH meter* or with special dyes called *acid-base indicators.* The color of an indicator depends on the concentration of hydro-gen ions. *pH paper* contains several indicators that change color at different pH's. When dipped into a solu-tion, the paper's color indicates the approximate pH of the solution. pH is used to analyze body secretions, to test soil suitability for certain crops, and for various in-dustrial purposes. Peter A. Rock

Phaëthon, *FAY uh thahn,* in Greek mythology, was the son of the sun god Helios and the sea goddess Clym-ene. To learn whether Helios was truly his father, Phaë-thon journeyed to the palace of the sun god in the east. There Helios, to reassure Phaëthon, promised to grant his son any favor. Phaëthon rashly asked to drive the sun chariot through the sky for one day. Helios reluctantly consented, but Phaëthon, being a mere mortal, was un-able to control the fiery divine steeds. They flew so high that the earth froze and a scar—the Milky Way—was carved on the sky. The steeds then flew so low that peo-ple were scorched black, streams dried up, and rocks split. Zeus, the king of the gods, rescued the world from destruction by striking Phaëthon with a thunderbolt. Phaëthon fell into a river and perished.

Nancy Felson

Phalarope, *FAL uh rohp,* is a small sandpiperlike bird that breeds in the Northern Hemisphere and winters in the Southern Hemisphere. The *red phalarope* and the *red-necked,* or *northern, phalarope* breed in the Arctic and subarctic. They winter on the high seas of the At-lantic and Pacific oceans.

The phalarope female is larger and more brightly col-ored than the male phalarope. The female does the courting and establishes the nesting territory. The male builds the nest and incubates the eggs. However, both the male and the female care for the young.

George L. Hunt, Jr.

Scientific classification. Phalaropes make up the phalarope family, Phalaropodidae. The scientific name for the red phala-rope is *Phalaropus fulicaria.* The red-necked phalarope is *P. loba-tus.*

See also **Bird** (picture: Birds of the Arctic).

Pharaoh, *FAIR oh,* was a title of the later kings of an-cient Egypt. The Egyptians did not call their ruler pharaoh until the Eighteenth Dynasty (1554-1304 B.C.). Even then, pharaoh was not one of the king's most im-portant titles. Writers of books in the Old Testament used the word *pharaoh* as a title for the king of Egypt.

The word *pharaoh* comes from two Egyptian words that mean *great house.* At first, these words described the royal palace, not the king.

Egyptians considered the pharaoh a god and the son of a god. They thought he was the sky god Horus in hu-man form, and the son of Re, the sun god. In theory, the pharaoh owned all the land and ruled the people. In re-ality, his power was sometimes limited by strong groups, including the priests and nobles. The pharaoh's actions were governed by rules of conduct that the Egyptians believed the gods had set down.

Leonard H. Lesko

See also **Egypt, Ancient** (Government; History); **Ram-ses II.**



Pharaoh Hound Club of America

The pharaoh hound is a sleek, swift-running dog.

Pharaoh hound is one of the oldest breeds of dogs. Pharaoh hounds originated in ancient Egypt, where they were used for hunting antelope and other game. Their likenesses have been found on walls of the tomb of Pharaoh Antefa II, dating to 2300 B.C. About 1500 B.C., the Phoenicians brought the breed to the island of Malta, where it survived into modern times. The breed was introduced into the United States in the 1950's.

Pharaoh hounds are sleek dogs that stand from 21 to 25 inches (53 to 64 centimeters) high at the shoulder and weigh from 35 to 50 pounds (16 to 23 kilograms). Their short, flat, glossy coat is a rich tan. Pharaoh hounds have white toes and a starlike white marking on the chest. The tip of their whiplike tail is also white, and many of the dogs have a white line up the center of the face. Pharaoh hounds "blush" when excited—that is, their nose and their erect ears change from the normal flesh color to a deep rose. Their eyes are an unusual amber color. Pharaoh hounds hunt by both sight and scent. They move swiftly and gracefully, and their bite is powerful.

Critically reviewed by the American Kennel Club

Pharisees, *FAR uh sees,* were members of an ancient Jewish group that became an important political party in Palestine during the reign of Queen Alexandra (76-67 B.C.). The political role of the Pharisees ended under the reign of Herod the Great (37-4 B.C.).

The Pharisees developed a philosophy that attributed an important role to fate and to God. They believed that even though people have free will, fate or God will also play a role in people's actions. The Pharisees also believed that a person's soul is either rewarded or punished after death.

In the Gospels, the Pharisees were not politicians or philosophers, but Jews who stressed the laws of dietary purity. According to the Gospels, the Pharisees ate only with other "pure" Jews, while Jesus and His disciples ate with people who did not keep the law. Also, the Pharisees stressed the washing of hands, while the early Christians ignored this practice. Similarly, the Pharisees fasted, but Jesus and His disciples did not.

The Gospels often portrayed the Pharisees as the main Jewish opponents of Jesus, who easily overcame their opposition. In Matthew, Saint John the Baptist called them "a brood of vipers," and in Luke, Jesus described them as hypocrites. These insults were directed at the Pharisees to contrast the ethical laws of Jesus with the purity laws and rituals of the group.

The Pharisees were often in conflict with another Jewish group called the Sadducees. Most of their disagreements revolved around issues of purity. The Pharisees believed that the purity laws should be kept by all Jews and were not limited to the priests and the area around the Temple in Jerusalem. The Pharisees believed that all Jews should eat as if they were priests presiding at the altar of the Temple. Gary G. Porton

Pharmacology, *FAHR muh KAHL uh jee,* is the scientific study of the effects chemicals have on living things. The scientists who study such chemical effects are known as *pharmacologists.* Pharmacologists consider all chemicals that affect living things to be drugs. Much of their study deals with how drugs modify tissue and organ functions. Pharmacology differs from *pharmacy,* which is a profession concerned mainly with the preparation and distribution of drugs for public use.

Pharmacology is divided into several fields. *Pharmacodynamics* studies the effects of drugs on living organisms. *Pharmacokinetics* deals with how the body takes up, distributes, and eliminates drugs. *Toxicology* deals with poisons and their effects, detection, and treatment. *Clinical pharmacology* examines the usefulness and poisonous qualities of drugs in the human body. Pharmacologists may work for universities, hospitals, government agencies, or pharmaceutical companies.

People have used plants and minerals to relieve or cure diseases since ancient times. Through the years, people have used such plants as the poppy, belladonna, and foxglove to treat certain conditions. The science of pharmacology began during the 1900's with the rise of chemistry. For the first time, scientists could analyze crude plant and mineral materials that acted on living tissues. By separating and studying the part of the plant or mineral that caused a reaction, scientists could then use the materials to make drugs. Barbara M. Bayer

See also **Drug; Pharmacy.**

Pharmacy is the profession concerned with the preparation, distribution, and use of drugs. Members of this profession are called *pharmacists* or *druggists.* They were once called *apothecaries.* The word *pharmacy* also refers to a place where drugs are prepared or sold. Most pharmacies, sometimes called drugstores, sell a variety of products in addition to drugs.

Duties of a pharmacist. Pharmacists fill prescriptions written by physicians or dentists and prepare labels for the medicines. On the labels, pharmacists include directions for patients given in prescriptions. At one time, pharmacists compounded their own medicines. Today, pharmaceutical manufacturers supply most drugs. But pharmacists must still compound some medicines and be able to prepare antiseptic solutions, ointments, and other common remedies. They also advise people on the selection of nonprescription drugs, such as cold tablets. In addition, pharmacists are responsible for the legal sale of narcotics and poisonous substances.

Training and careers in pharmacy. To become a pharmacist in the United States, a person must graduate from an accredited college of pharmacy. After finishing

his five- or six-year program, graduates must complete one year of internship under the supervision of a practicing pharmacist. Each state requires graduates to pass a state board examination before granting them a license to practice in the state. Canada has similar training requirements for pharmacists.

The United States has more than 70 accredited colleges of pharmacy, and Canada has 9. Most of these colleges are part of a large university. Pharmacy students must take courses in the biological sciences, chemistry, and mathematics, as well as in the humanities, to receive a bachelor's degree in pharmacy. They also must complete specialized professional courses. These courses include *pharmacology,* the study of the effects of drugs on living things; *pharmaceutics,* the physical chemistry of drugs; and *clinical pharmacy,* the application of the pharmaceutical sciences to patient care. A master's or doctor's degree is required for work in certain fields. Pharmacists may work in clinics, drugstores, hospitals, industrial plants, or research laboratories. They may also work for the military or government.

The American Pharmaceutical Association is the national organization of pharmacists in the United States. It was founded in 1852. The association seeks to maintain high standards of practice among its members. Information about career opportunities in pharmacy can be obtained by contacting the American Association of Colleges of Pharmacy in Alexandria, Virginia.

Christopher A. Rodowskas, Jr.

See also Drug; Pharmacology.

Pharos of Alexandria. See Seven Wonders of the Ancient World (The Lighthouse; picture).

Pharynx, *FAR ihngks,* is a cone-shaped tube that connects the nose and mouth with the voice box and *esophagus* (tube leading to the stomach). The pharynx is about 5 inches (13 centimeters) long and has muscular walls lined with mucous membrane. It serves as a passageway for both air and food. In addition, the pharynx plays an important role in speech, especially in the production of vowel sounds.

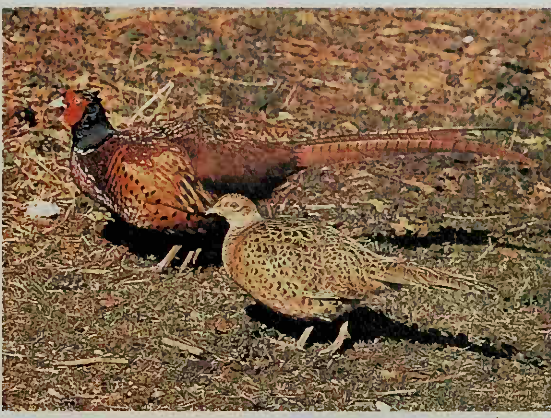
When a person breathes in, air enters the pharynx from the nose or mouth. The air then passes through the *larynx* (voice box) and *trachea* (windpipe) into the lungs. This route is reversed when a person exhales.

Food enters the pharynx from the mouth. When a person swallows, a flap of cartilage called the *epiglottis* covers the opening of the larynx, and the vocal cords automatically clamp shut. These actions keep food from entering the trachea. Instead, it travels down the esophagus to the stomach. Barry L. Wenig

See also Mouth (diagram).

Pheasant, *FEHZ uhnt,* is the name of several species of medium-to-large birds closely related to peacocks and junglefowls. Pheasants are also related to the domestic chicken. Most pheasants are native to China and countries of Central and Southeast Asia. But some species have been brought to other parts of the world, where they have been released for hunting. People hunt pheasants for sport and for their tasty meat. Pheasants are also sought for their feathers.

Appearance and habits. Most pheasants have a long tail and a short, stout bill. Some have flaps of red skin on their heads forming *combs* or *wattles.* Males are called *cocks.* Nearly all cocks have beautiful patterns of brightly colored feathers. Females, called *hens,* have duller feathers of brown and tan with black markings.



Jane Burton, Bruce Coleman Ltd

Ring-necked pheasants are popular game birds. The male's head and neck have bright feathers. The female is drab-colored.



Kenneth W. Fink, Photo Researchers

Male golden pheasants have bright yellow heads and brilliant red breasts. Their colors make them attractive to females.

Most pheasants inhabit woodlands, but some species prefer cultivated fields. Other species of pheasants live in grasslands high in the Himalaya. Most pheasants do not undertake long migrations, but many make short seasonal journeys in search of food. Pheasants eat seeds, fruits, roots, greens, flowers, and insects and other small animals without backbones. Pheasants spend most of their time on the ground, although many species perch in trees at night. The birds can fly only for short distances but may reach speeds of 40 miles (64 kilometers) per hour.

In spring, pheasant cocks fight for possession of a mating area. They then attract hens by showing off their elegant feathers. The cocks accompany such elaborate displays with cackles, crows, screams, and whistles. The calls of the hens are limited mostly to clucks and peeps. A cock's territory usually includes several hens, with which he mates. Nearly all pheasants nest on the ground. The hen builds a nest of twigs and leaves in a secluded spot. But sometimes pheasants use a nest left in a tree. Hens lay from 2 to 15 eggs. Their eggs are plain or speckled and may be white, tan, or olive.

Kinds of pheasants. There are about 35 species of pheasants. One familiar species, the *ring-necked pheasant,* was found originally in central Asia. The Romans spread these birds to Europe about 2,000 years ago. Ring-necks were brought to North America in the 1800's, and they soon became a familiar game bird. Male ring

necks grow to a length of 30 to 36 inches (76 to 91 centimeters), including the tail. Their head and neck are covered with shiny greenish-blue feathers, and their body is brown, black, and white. Many cocks have a white band around their neck. Red skin encircles their eyes. The hens are mottled brown. They grow to a length of 21 to 25 inches (53 to 64 centimeters).

Another well-known species, the *golden pheasant,* adapts well to captivity and is a favorite in zoos. The male has a golden-yellow head and brilliant red breast. Golden pheasants come from the mountain forests of Tibet and central China, where they have become a rare species.

The large *Reeves pheasant* lives in small groups in the mountains of China. As part of its courtship dance, the cock ruffles its shimmering golden feathers and leaps repeatedly high into the air. During flight, it may use its long tail as a rudder or a brake. Bertin W. Anderson

Scientific classification. Pheasants belong to the family Phasianidae. The scientific name for the ring-necked pheasant is *Phasianus colchicus,* the golden pheasant is *Chrysolophus pictus,* and the Reeves pheasant is *Syrmaticus reevesi.*

See also **Bird** (picture: How wing shape affects flying skills); **Tragopan.**

Pheidippides. See Marathon.

Phenolic, *fih NOH lihk* or *fih NAHL ihk,* is any of a group of strong and inexpensive plastics materials. Phenolics are resistant to heat and to most solvents. They are excellent electrical insulators. Among the products made of phenolics are light switches, gears, and saucepan handles.

Phenolics are synthetic *polymers.* A polymer is a long, chainlike molecule. The "links" of the chains are repeating patterns of simple groups of atoms known as *monomers.* Phenolics are *thermosetting plastics*—that is, once the plastic has been formed, it cannot be reshaped by heat, pressure, or other physical means (see **Plastics** [Types of plastics]). Because of these properties, phenolics cannot be recycled.

Manufacturers use several different methods to produce phenolics. In the most common method, one of a group of organic compounds called *phenols* is mixed with formaldehyde in the presence of a *catalyst.* A catalyst is a substance that speeds up a chemical reaction without being used up by the reaction. The mixture is slowly heated, causing the molecules of formaldehyde to form chemical bridges between the *benzene rings* (ringlike structures of six carbon atoms) in the phenol molecules.

Manufacturers frequently add fillers or additives to phenolics to change their properties to suit various applications. Most phenolic products are shaped, using heat and pressure, in a process called *compression molding.* In addition, porous materials may be saturated with phenol and formaldehyde, allowing a phenolic to form within the structure of the material. This process is performed with wood to produce Formica-brand tabletops and other work surfaces. A similar process combines phenolic with certain mineral fibers or synthetic fibers to make brake linings for automobiles.

Phenolics are among the oldest plastics. The Belgian-born American chemist Leo Hendrik Baekeland developed the first phenolic in 1907. He patented it in 1909 as Bakelite. Stephen H. Carr

Phenology, *fih NAHL uh jee,* is the study of when certain biological events that depend on climate take place. Phenologists study how these events are affected by seasonal weather changes. The events include the migration of birds, the hibernation of animals, and the sprouting and flowering of plants. Farmers and others whose work is affected by weather can use the information to plan their activities. For example, in some areas alfalfa is ready to be cut about 30 days after the common lilac blooms. Farmers in these areas can predict when they will have to cut their alfalfa by observing when lilacs bloom.

Scientific organizations in the United States and other countries have formed networks of people who observe and report on certain phenological events. The organizations use the information to make *phenological maps.* Lines on the maps connect the places in which living things reach a certain stage at the same time.

Artificial satellites provide data on atmospheric temperatures, solar radiation, and the reflection of the earth's surface. This information helps scientists detect certain phenological events worldwide. For example, phenologists use this information to determine when vegetation will become green—or turn brown—in various regions. The data can be used to develop mathematical models of the life cycles of plants and animals raised in different climates. George B. Johnson

Phenolphthalein, *FEE nohl THAL een* (chemical formula, $C_{20}H_{14}O_4$), is a chemical compound used as an indicator of alkalinity or acidity, and as a laxative. It is also used in making dyes.

Phenolphthalein is prepared by heating phenol and phthalic anhydride with sulfuric acid. Pure phenolphthalein forms small crystals that dissolve in alcohol or ether. It turns red in the presence of an alkaline substance.

As a laxative, phenolphthalein is the active ingredient in many medicines. It is one of the least poisonous of common laxatives, but some people are allergic to it. Thus, it must be used with care. Patrice C. Bélanger

Phenomenology, *fuh NAHM uh NAHL uh jee,* is a philosophy that was developed by the German philosopher Edmund Husserl in the early 1900's. Husserl wanted to understand how consciousness works in order to better understand human experience. Consciousness refers to the power of the mind to be aware of acts, sensations, and emotions. Husserl believed that everything we know about reality derives from our consciousness.

For phenomenologists, experience has two parts. The first part consists of *objects of consciousness* (the things of which one is conscious). Objects of consciousness, which include material objects, ideas, and wishes, are called *phenomena.* The second part of experience consists of *acts of consciousness,* such as perceiving, believing, thinking, and desiring. Phenomenologists believe that all acts of consciousness are related to objects of consciousness and thus must also be considered phenomena. This relationship is called *intentionality.*

The phenomenological method starts with the theory that people normally make certain assumptions about their experiences. They consider the things they have been taught, and remember past experiences. Such presuppositions limit their experiencing of phenomena. Phenomenologists realize that it is impossible to entirely

iminate these presuppositions from the mind. Instead, ey try to expand their experiencing of phenomena by ealing with the presuppositions critically. One critical ethod involves *fantasy variations.* The philosopher var-s the presuppositions, imagining how the experience ould be perceived under varying circumstances. The atures of the experience that remain constant despite e variations are considered its *essence.*

Husserl has had many followers. They include the ench psychologist Maurice Merleau-Ponty and the erman philosopher Martin Heidegger. Both men ar-ued that phenomenology should not be limited to an nalysis of consciousness. Instead, they used the phe-omenological method to analyze human existence in eneral. The method has also been successfully applied specific fields, such as anthropology, law psychiatry, sychology, religion, and sociology. Don Ihde

henylketonuria (PKU), *FEHN uhl KEE tuh NYUR ee h,* is a hereditary disease that results in mental retarda-on unless treated during early infancy. It occurs chiefly people of western European ancestry. The bodies of eople with PKU accumulate too much *phenylalanine,* ne of the amino acids that make up proteins. For un-nown reasons, an excess of phenylalanine in an infant's ody harms development of the brain and intelligence.

PKU is caused by a *mutation* (change) in a gene that al-rs the function of the enzyme *phenylalanine hydroxy-se.* This enzyme normally converts phenylalanine to e amino acid *tyrosine.* In PKU patients, the conversion oes not take place properly. Phenylalanine is an essen-al part of the human diet and it builds up in the bodies f PKU patients who eat normal foods.

Doctors diagnose PKU by testing the infant's blood a w days after birth. An abnormally high level of phenyl-anine may indicate the presence of the disease. Fur-ier laboratory tests confirm the diagnosis.

In treating PKU, doctors prescribe a diet low in phe-ylalanine. Such a diet includes fruits and certain vege-bles and cereals. Milk, milk products, meat, fish, and ther high-protein foods should be avoided. Treatment ust begin before the patient is two months old to en-ure normal mental development. Many doctors recom-iend that treatment continue through childhood. Vomen with PKU may follow a special diet before and uring pregnancy to protect the brain development of n unborn baby. Charles C. Black and Charles R. Scriver

heromone, *FEHR uh mohn,* is a chemical substance eleased by many kinds of animals to communicate with ther members of their species. The animals that se-rete pheromones range from one-celled organisms to iesus monkeys and many other mammals.

Both males and females use pheromones to establish rritories, warn of danger, and attract mates. For exam-le, certain ants, mice, and snails release *alarm phero-ones* when injured or threatened. The odor warns ther members of the species to leave the area. A heromone secreted by the queen bee of a hive pre-ents all the other females in the group from becoming exually mature. The queen then becomes the only bee the hive that can mate and lay eggs. Scientists have iscovered evidence of pheromones in human beings ut do not know whether they affect human behavior.

Since 1959, chemists have developed synthetic phero-iones that are used to control insect pests. Unlike many pesticides, pheromones do not harm the environment. Artificial female pheromones of such insects as moths and beetles are used to bait traps that capture males of the same species. In another method of pest control, called *communication disruption,* farmers spread their crops with fibers soaked in an insect pheromone. The odor of the pheromone prevents the male insects from finding the females for mating. George B. Johnson

Phi Beta Kappa, *FY BAY tuh KAP uh,* is a college and university honor society that encourages scholarship in the liberal arts and sciences. It is the oldest American fraternity with a Greek-letter name. Both men and women can belong to it.



WORLD BOOK photo

Phi Beta Kappa key

Phi Beta Kappa was founded in 1776 at the College of William and Mary, Williamsburg, Va. It was first organized as a secret society devoted to literary and philosophical discussion. During the 1800's, the organization abandoned secrecy and became an honor society. Today, members are elected primarily by Phi Beta Kappa college faculty. They select new members from seniors and juniors with high academic records. Membership is sometimes conferred for scholarship after graduation. The letters ΦBK (Phi Beta Kappa) are the initials of the Greek words Φιλοσοφία Βίου Κυβερήτης, meaning *Philosophy* (*is*) *the Guide of Life.*

Phi Beta Kappa has active chapters at about 240 colleges and universities in the United States, and a living membership of about 425,000. Its regular program includes scholarships and book awards, sponsored by individual chapters, graduate associations, and the national organization. It publishes two magazines: *The Key Reporter,* for members, and *The American Scholar,* for all interested persons. The national organization, called the Phi Beta Kappa Society, has headquarters in Washington, D.C. Critically reviewed by the Phi Beta Kappa Society

Phidias, *FIHD ee uhs* (490?-420? B.C.), was the greatest sculptor in ancient Greece. His artistry was largely responsible for the High Classical style of sculpture during the Golden Age of Athens in the 400's B.C.

Phidias is best known for his designs for the sculptures on the Parthenon. Phidias conceived and designed these works, though he may not have actually made them. He created statues of gods and goddesses primarily in marble, but occasionally in gold and ivory. These statues were unrivaled in the ancient world for their majesty and grandeur.

None of Phidias' statues survive, but ancient authors describe a great gold and ivory statue of Athena Parthenos. It stood in the Parthenon and was more than 35 feet (11 meters) high. Phidias was most famous for his gigantic gold and ivory statue of the seated Zeus, ruler of the gods. This statue was created for the temple at Olympia. Marjorie S. Venit

See also **Elgin Marbles; Greece, Ancient** (picture: Athena); **Parthenon; Seven Wonders of the Ancient World** (The statue of Zeus).

© Superstock

Philadelphia's City Hall is one of the largest city halls in the United States. On top of its huge tower stands a statue of William Penn, the English Quaker who founded the city.

Philadelphia

Philadelphia is the birthplace of the United States. The Declaration of Independence and the Constitution of the United States both were signed in Philadelphia's historic Independence Hall. The city was the capital of the American Colonies during most of the Revolutionary War in America (1775-1783).

Philadelphia is Pennsylvania's largest city and one of the largest cities in the United States (see **United States** [table: The 50 largest cities]). It lies in southeastern Pennsylvania on the Delaware River. The river flows into the Atlantic Ocean and helps make Philadelphia one of the nation's busiest freshwater ports. The city is also a national center of culture, education, finance, and health care. The Philadelphia area is a center of the pharmaceutical industry in the United States.

William Penn, an English Quaker, founded Philadelphia in 1682. Penn, who had been persecuted for his Quaker beliefs, planned Philadelphia as a center of religious freedom. The word *philadelphia* means *brotherly love* in Greek, and Philadelphia was nicknamed the City of Brotherly Love. It also became known as the Quaker City because many of its first settlers were Quakers. Today, the American Quakers have their headquarters in Philadelphia. During the 1700's, Philadelphia developed into the largest, wealthiest city in the American Colonies.

Few cities in the United States can match Philadelphia's historic attractions. Every year, millions of visitors thrill to the sight of Independence Hall and the Liberty Bell. Many visitors enjoy touring Carpenters' Hall and Congress Hall, where Benjamin Franklin, Thomas Jefferson, and other early leaders laid the foundations of a new nation. Philadelphians also take pride in the city's world-famous orchestra, excellent colleges and universities, scenic parks, and outstanding museums.

Philadelphia faces problems common to many other large industrial cities. During the last half of the 1900's, many manufacturing companies closed or moved out of the city, resulting in the loss of tens of thousands of jobs. During the same period, the population decreased by hundreds of thousands of people. The loss of jobs and people left the city's working-class neighborhoods with numerous closed factories and block after block of abandoned homes. Jobs are available in high-technology firms that have begun operations in Philadelphia's fast-growing suburbs. But many city residents lack the necessary education for these jobs and even the transportation to reach them.

Philadelphia's leaders have been working to expand tourism to help revive the city's economy. By highlighting the area's historical significance, they have encouraged investments in such projects as new hotels and restaurants.

The city

Philadelphia covers 144 square miles (373 square kilometers), including 9 square miles (23 square kilometers) of inland water. It lies in Philadelphia County, but the city and the county have the same boundaries. Thus, Philadelphia is both a city and a county.

The Delaware River runs east and south of Philadel-

hia and separates it from New Jersey. The Schuylkill ›ronounced *SKOOL kihl)* River flows through Philadelhia and into the Delaware River at the southern edge f the city. Downtown Philadelphia, called Center City, es between the two rivers. Philadelphia's chief residenal districts are north, south, and west of Center City.

Downtown Philadelphia. Philadelphia's huge City lall covers about 5 acres (2 hectares) in the center of owntown. It is one of the largest city halls in the United tates. A tower rises from the front of the white granite nd marble building. A bronze statue of William Penn n top of the tower ranks as the world's largest sculpure atop a building. The statue is 37 feet (11 meters) tall nd weighs 53,523 pounds (24,278 kilograms). The disance from the ground to the top of the statue is nearly 48 feet (167 meters). Philadelphia's chief city governnent buildings border the streets around City Hall.

South of City Hall is a section of Broad Street called ne Avenue of the Arts. This street is home to a number f the city's arts organizations, including the Philadelhia Orchestra, the Opera Company of Philadelphia, and ne Pennsylvania Ballet. Fashionable shops and expenive restaurants spread west of the arts district along Valnut Street and around Rittenhouse Square.

The area west of City Hall has become a district of skycrapers. Until 1984, no building rose higher than the tatue of Penn. Since 1984, however, the Philadelphia kyline has changed greatly. Several office buildings in ne area west of City Hall tower 50 stories or more.

Northwest of City Hall, four of Philadelphia's finest nuseums stand near the Benjamin Franklin Parkway, a eautiful treelined boulevard modeled after the Champs lysées in Paris. These museums are the Academy of Jatural Sciences of Philadelphia, the Franklin Institute, he Rodin Museum, and the Philadelphia Museum of \rt. The parkway ends near the entrance to Fairmount 'ark. One of the nation's largest city-owned parks, Fairnount Park stands along the Schuylkill River and Wisahickon Creek. The art museum neighborhood in-ludes dozens of blocks of historic homes along narow, treelined streets. Northeast of City Hall are Chinaown and the large Pennsylvania Convention Center.

Philadelphia's chief historic area lies east of City Hall. It enters on the 22-acre (9-hectare) Independence Nation-l Historical Park, which includes Independence Hall. Inide this handsome red brick building on Chestnut itreet, visitors may see the room where the Declaration of Independence and the Constitution were signed. The amous Liberty Bell hangs in a pavilion across from Inlependence Hall. Nearby are Congress Hall, the home of Congress from 1790 until 1800; and Carpenters' Hall, vhere the First Continental Congress met in 1774.

Other famous structures stand throughout the historic irea. The Betsy Ross House on Arch Street is where the amous seamstress may have made what became the irst United States flag in 1777. Christ Church, an Episco-al church built on Second Street between 1727 and 744, contains the pews of Benjamin Franklin, George Vashington, and other famous Americans. About 35 rick houses built during the early 1700's line Elfreth's \lley, a narrow, block-long cobblestone street between \rch and Race streets. It is the nation's oldest street of ontinuously occupied homes. On Fifth Street, the argest United States Mint produces hundreds of millions of dollars worth of coins each year.



WORLD BOOK map

Philadelphia is in southeastern Pennsylvania.

The area around Independence National Historical Park includes several historical museums. They are the African American Museum in Philadelphia; the Atwater Kent Museum, which focuses on Philadelphia history;

Facts in brief

Population: *City*—1,517,550. *Metropolitan area*—5,100,931. *Consolidated metropolitan area*—6,188,463 (3,849,647 in Pennsylvania, 1,752,600 in New Jersey, 500,265 in Delaware, and 85,951 in Maryland).

Area: *City*—144 mi² (373 km²). *Metropolitan area*—3,586 mi² (9,288 km²). *Consolidated metropolitan area*—5,936 mi² (15,374 km²).

Climate: *Average temperature*—January, 35 °F (2 °C); July, 76 °F (24 °C). *Average annual precipitation* (rainfall, melted snow, and other forms of moisture)—43 in (109 cm). For the city's monthly weather, see **Pennsylvania** (Climate).

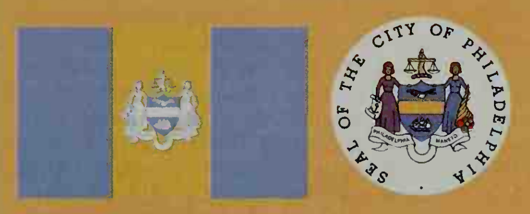
Government: Mayor-council. *Terms*—4 years for the mayor and the 17 council members.

Founded: 1682. Incorporated as a city in 1701.

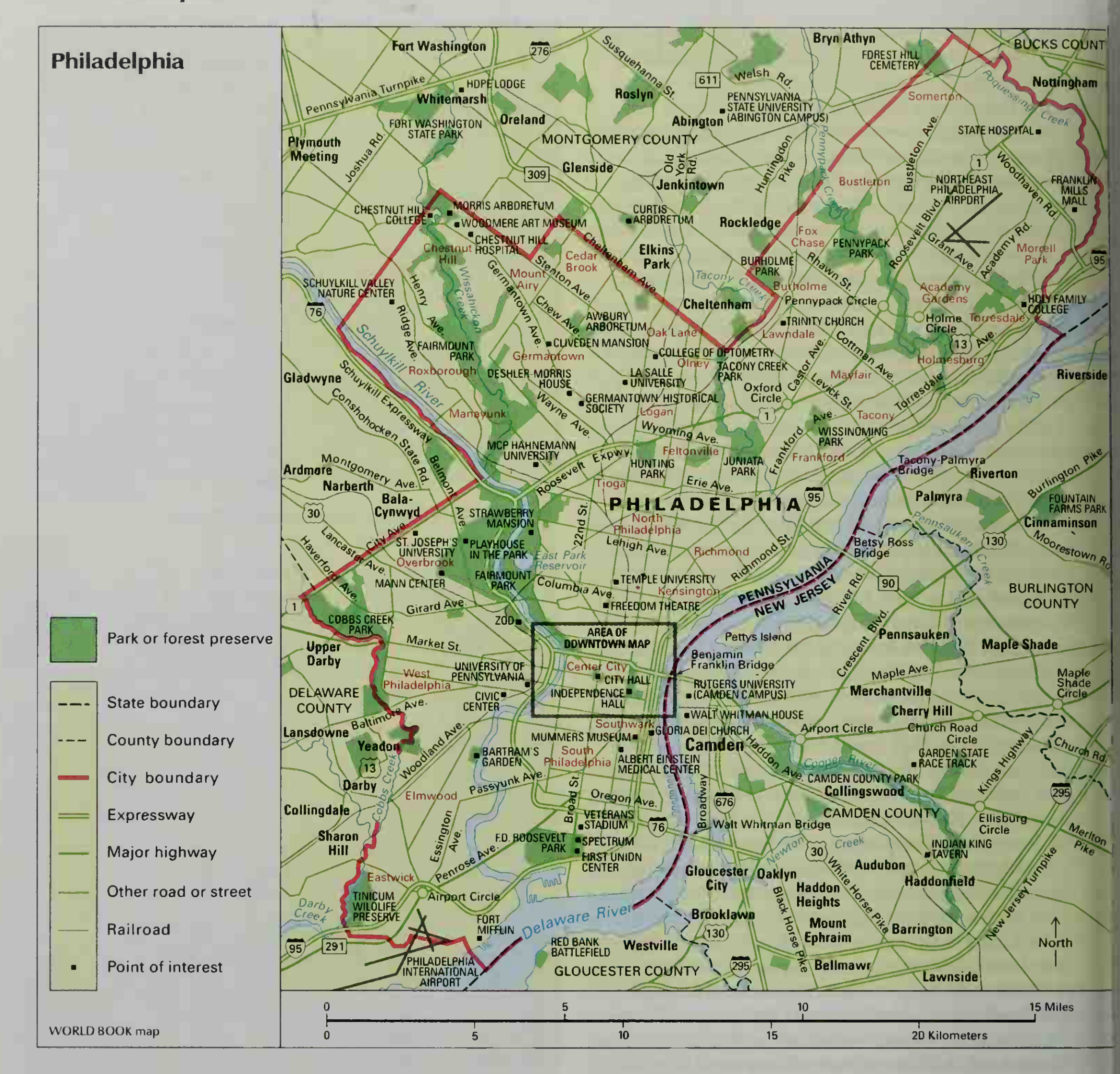
Largest communities in the Philadelphia area

Name	Population	Name	Population
Philadelphia, PA	1,517,550	Gloucester, NJ*	64,350
Upper Darby, PA*	81,821	Lower Merion, PA*	59,850
Camden, NJ	79,904	Bensalem, PA*	58,434
Wilmington, DE	72,664	Abington, PA*	56,103
Cherry Hill, NJ*	69,965	Bristol, PA*	55,521

*Township. Source: 2000 census.



Symbols of Philadelphia. The city's flag was adopted in 1895. The city seal, *right,* appears on the flag. The seal, which was adopted in 1874, includes Philadelphia's motto, *Philadelphia Maneto,* which means *Let Brotherly Love Continue.*



the Balch Institute for Ethnic Studies; and the National Museum of American Jewish History. The historical area is also the site of Old City, Philadelphia's oldest neighborhood. Artists helped to revitalize the neighborhood, formerly an industrial area. Old City now includes many galleries, antique shops, and cafes.

Residential districts. Society Hill, one of Philadelphia's chief historic neighborhoods, lies south of Independence National Historical Park. Society Hill includes hundreds of restored 200-year-old homes, and many blocks look much as they did in colonial times. Historic churches there include St. Mary's Church, a Roman Catholic church built in 1763; Old Pine Street Presbyterian Church, erected in 1768; and Mother Bethel African Methodist Episcopal Church, built in 1818. Modern town houses and apartment buildings stand nearby in sharp contrast to the old structures.

Directly south of Society Hill is Southwark, the oldest section of Philadelphia. Swedish immigrants settled there during the early 1600's. Gloria Dei (Old Swedes') Church, Pennsylvania's oldest church, opened in the area in the 1640's.

The southern section of Philadelphia includes the neighborhood of South Philadelphia. People of Italian descent once made up the largest ethnic group in this neighborhood. The colorful, lively outdoor Italian Market still attracts shoppers from throughout the city and suburbs. Many people from Southeast Asia have moved here, and Italian restaurants now share the neighborhood's narrow streets with Thai and Vietnamese restaurants. Farther south stand three stadiums that make up Philadelphia's main sports complex. Philadelphia International Airport lies southwest of the sports complex.

University City, a neighborhood across the Schuylkill River and west of Center City, has a notable complex of hospitals and universities. These facilities include Drexel University, the University of Pennsylvania, the University of Pennsylvania Hospital, and the internationally known Children's Hospital of Philadelphia. The West Philadelphia neighborhood lies west of University City.



Werner Wolff, Black Star

Independence Hall, where the Declaration of Independence and the U.S. Constitution were signed, stands in Independence National Historical Park in downtown Philadelphia.



L. L. T. Rhodes from Nancy Palmer

Homes in Society Hill, one of Philadelphia's most historic neighborhoods, look much as they did during colonial times. Society Hill is noted for its mixture of old and modern buildings.

Downtown Philadelphia

0 1/2 1 11/2 2 21/2 Miles

0 1/2 1 11/2 2 21/2 3 31/2 4 Kilometers

WORLD BOOKmap



Harvey Lloyd, Black Star

Row houses are the most common type of housing in Philadelphia. Each of these houses shares at least one wall with the house next door. Most of the structures are two- or three-story brick buildings.

North Philadelphia borders Center City on the north. Many of the neighborhoods in this area have declined, and many of the residents are among the city's poorest people. African American churches have played a large role in rebuilding these neighborhoods. The Opportunities Industrialization Center, a noted private job-training center, is in North Philadelphia. African American businesspeople own and operate Progress Plaza, a nearby shopping center. Temple University is also in North Philadelphia.

Neighborhoods farther north include Manayunk, Germantown, and Chestnut Hill. Manayunk, along the Schuylkill River, was once a neighborhood of textile mills. It is now home to many popular shops and restaurants. Dutch and German Quakers founded Germantown in 1683. The community remained independent of Philadelphia until 1854. Germantown's historic buildings include Cliveden, an elegant mansion built in 1767; and the Deshler-Morris House, where President George Washington lived briefly in 1793. Chestnut Hill is an area of mansions and fine shops. Attractive residential neighborhoods with wide streets and modern shopping areas spread over most of the northeastern Philadelphia area.

The metropolitan area of Philadelphia covers 3,586 square miles (9,288 square kilometers). It extends over Bucks, Chester, Delaware, Montgomery, and Philadelphia counties in Pennsylvania and across Burlington, Camden, Gloucester, and Salem counties in New Jersey. The metropolitan areas of Atlantic City, Philadelphia, and Wilmington form the Philadelphia-Wilmington-Atlantic City Consolidated Metropolitan Statistical Area.

Philadelphia's best-known suburbs include old, elegant communities called Main Line towns. They lie west of the city along what was once the main line of the Pennsylvania (now Penn Central) Railroad. These communities include Ardmore, Devon, Paoli, and the college towns of Bryn Mawr, Haverford, and Villanova.

The metropolitan area includes three famous Revolutionary War sites. At Brandywine Battlefield, southwest of Philadelphia, the British defeated American forces in September 1777 and went on to capture Philadelphia. Valley Forge National Historical Park, west of the city, occupies the site where the colonial army camped during the difficult winter of 1777. Washington Crossing State Park, north of Philadelphia, marks the site where General George Washington and his troops crossed the Delaware River by night to make a surprise attack on the Hessians at Trenton, New Jersey, in 1776.

The people

Ethnic groups. English and Welsh Quakers who accompanied William Penn were the first settlers in Philadelphia. Other Europeans followed in three major waves of immigration. Many English people arrived throughout the 1700's. In the second wave, from the 1830's to the 1880's, large numbers of families came from England, Germany, Ireland, Scotland, and Wales. In the third wave, in the early 1900's, many immigrants came from Austria, Hungary, Italy, Poland, and Russia.

Blacks began to come to Philadelphia during the 1600's because of the Quaker belief in racial equality. African Americans from the Southern States started to migrate to the city in large numbers during and after World War I (1914-1918).

Today, about half of the people of Philadelphia have European ancestry, and most of the rest are African Americans. Other residents include people of Hispanic or Asian backgrounds.

Education. Philadelphia has more than 250 public schools. The city's private and parochial schools include Catholic, Jewish, and Quaker schools.

Philadelphia has about 20 colleges and universities. The Pennsylvania Academy of the Fine Arts, founded in Philadelphia in 1805, is the oldest art school in the United States. The Moore College of Art, the nation's oldest art school for women, opened in the city in 1844. The first U.S. medical school that admitted only women was the Woman's Medical College of Pennsylvania, established in Philadelphia in 1850. It began to admit men in 1969 and is now part of MCP Hahnemann University.

Philadelphia also has a number of other medical
hools and ranks among the country's leading medical
nters. The University of Pennsylvania, located in
iladelphia, was founded in 1740 and began granting
chelor's degrees in 1757. It is the sixth oldest universi-
in the United States. Temple University is Philadel-
ia's largest institution of higher learning, and it is a
ajor research institution. Other colleges and universi-
s in the city include Drexel, La Salle, and St. Joseph's
iversities.

About 30 colleges and universities are near Philadel-
ia. One of them, Bryn Mawr College, was one of the
st U.S. colleges for women. It was established in 1885.
her schools near the city include Haverford and
varthmore colleges and Villanova University.

Housing. More than 60 percent of Philadelphia's fami-
s own their homes. Most of the rest rent apartments.
ick town houses called row houses are the most com-
on type of housing in the city. These homes line entire
eets in parts of Philadelphia. Each has two, three, or
ur stories and shares at least one wall with the house
xt door. Many of Philadelphia's most expensive homes
e in Chestnut Hill, in the northwestern part of the city,
d in Society Hill, a part of Center City. Center City has
number of high-rise apartment buildings.

Thousands of Philadelphians with low incomes lack
cent housing. Many of them live in decaying apart-
ent buildings and row houses in North Philadelphia,
uth Philadelphia, and West Philadelphia. Thousands
housing units in run-down buildings are vacant. A
mber of the owners have died. Other owners have
oved away and abandoned houses in declining neigh-
rhoods that they could not sell. Philadelphia has a
ogram that offers certain abandoned buildings at no
st to people who promise to repair and occupy them.

Social problems. Philadelphia, like other large cities,
ces many problems, including poverty, crime, and ille-
l drug use. It struggles with an inadequate public edu-
tion system. Most of the city's poor people suffer from discrimination or lack education and job skills. They live in run-down dwellings. Large numbers have no jobs, and many others work long hours for low wages. Such poor living conditions contribute to the city's crime rate. In addition, the buying and selling of illegal drugs increases the number of violent crimes in the city.

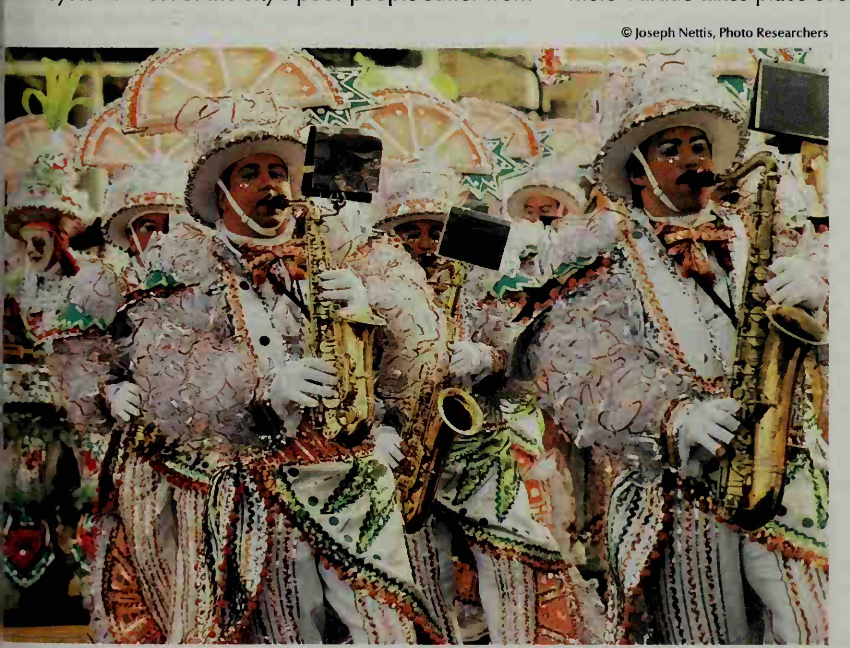
City officials have tried to solve these social problems by improving the public schools, upgrading the police department, and encouraging economic development. Crime has fallen, but many residents of poor neighborhoods still face limited opportunities.

Cultural life and recreation

The arts. The Walnut Street Theatre, one of several professional theaters in downtown Philadelphia, is the oldest active theater in the United States. It presented its first play in 1809. The city's strong theatrical tradition is evident in such professional companies as the Wilma Theater and the Arden Theatre Company and in the experimental plays presented at the University of Pennsylvania and Temple University. The Freedom Theatre is an important part of the city's African American cultural scene. The People's Light and Theatre Company, in suburban Malvern, has won national recognition.

Philadelphia's magnificent Academy of Music, which opened in 1857, is the oldest opera house in the United States still in use. It is the home of the Pennsylvania Ballet as well as the Opera Company of Philadelphia. The Kimmel Center is the home of the Philadelphia Orchestra. The center is also the home of such arts groups as the Chamber Orchestra of Philadelphia and the Philadelphia Chamber Music Society. During the summer, the Philadelphia Orchestra and other musical groups present free outdoor concerts at the Mann Center for the Performing Arts in Fairmount Park.

The Mummers' String Bands, which together form one of Philadelphia's top performing groups, have won fame for their elaborate costumes. The festive Mummers' Parade takes place every New Year's Day.



The Mummers' Parade features marching bands in elaborate and colorful costumes. This festive Philadelphia event is held annually on New Year's Day.



Leif Skoogfors from Woodfin Camp, Inc.

The Rodin Museum in Philadelphia has an outstanding collection of works by th famous French sculptor Auguste Rodin. The collection features one of Rodin's best-known works, *The Burghers of Calais, shown here.*

Libraries and museums. The Library Company of Philadelphia, which Benjamin Franklin helped establish in 1731, became the nation's first library to circulate books for a membership fee. Members of the company paid dues to buy books for the company, which members then could borrow free of charge. Today, the library still owns volumes that once belonged to Thomas Jefferson, William Penn, and George Washington. The Historical Society of Pennsylvania, next door to the library, has one of the finest collections of books on United States history. The American Philosophical Society houses an outstanding research library in Library Hall.

Philadelphia's public library system is called the Free Library of Philadelphia. It has a number of branches and owns a fine collection of rare books.

The four museums near the Benjamin Franklin Parkway rank among the finest in the world. The collection of the Philadelphia Museum of Art includes many superb paintings by French masters. The Rodin Museum exhibits works by the French sculptor Auguste Rodin. The Academy of Natural Sciences, founded in 1812, is the oldest natural-science museum in the United States. It has a world-famous display of stuffed birds and a large dinosaur exhibit. The Franklin Institute, established in 1824, was the nation's first museum of science and technology. It features exhibits on communication, computers, nuclear energy, and space travel. The institute also includes a large-screen theater and a planetarium.

The Pennsylvania Academy of the Fine Arts is the oldest art museum in the United States. This museum opened in 1805 and has many paintings from colonial times. Well-known art galleries in the city include the Philadelphia Art Alliance and the Rosenbach Museum.

The Atwater Kent Museum specializes in the history of Philadelphia. Balch Institute has exhibits on 300 years of immigration to America. Other notable Philadelphia museums include the African American Museum in Philadelphia, the Mummers Museum, the National Museum of American Jewish History, the Independence Seaport Museum, and the Please Touch Museum, which features exhibits and activities for children ages 1 to 7.

Recreation. Philadelphia's park system includes about 325 parks and playgrounds. Fairmount Park is the chief recreational area. In summer, people stroll or ride bicycles along its 45 miles (72 kilometers) of cool, shaded trails. Park visitors also may tour six colonial mansions that have been restored to their original elegance or sip tea in a Japanese teahouse. The Philadelphia Zoo forms part of the park.

Philadelphia has several professional sports teams. They include the Philadelphia Eagles of the National Football League, the Philadelphia Flyers of the National Hockey League, the Philadelphia Phillies of baseball's National League, and the Philadelphia 76ers of the National Basketball Association. The Army-Navy game, one of the most colorful college football rivalries, takes place in Philadelphia in late November or early December.

Economy

Service industries. Most of the city's workers are employed in service industries. Philadelphia's most important service industries are education, finance, health care, and trade.

Educational institutions provide jobs for many of Philadelphia's workers. The city and its surrounding area have dozens of colleges and universities.

Several important financial institutions have their headquarters in the city. They include the Third Federal Reserve District Bank and the Philadelphia Stock Exchange. The U.S. Mint at Philadelphia is one of the two mints that make most of the coins intended for general circulation in the United States. The other mint is in Denver. Philadelphia's commercial banks and insurance companies employ many workers.

Philadelphia's thriving health care industry is based on the approximately 50 hospitals and 6 medical schools in the city. Major hospitals include Thomas Jefferson University Hospital and the Albert Einstein Medical Center. Medical schools include the University of Pennsylvania School of Medicine, MCP Hahnemann University,

ıd the Temple University School of Medicine.

The wholesale trade industry in Philadelphia relies ːavily on the city's port, which is one of the busiest ːshwater ports in the United States. The major prod-ːts shipped through the port are chemicals, food prod-ːts, and petroleum. The large numbers of tourists that ʂit each year strengthen the city's retail trade.

Manufacturing. Philadelphia ranks high in clothing oduction among U.S. cities. The city's clothing industry ıecializes in finishing expensive products from interna-ɔnal factories.

Philadelphia also manufactures chemicals, fabricated etal products, and processed foods. Pharmaceuticals e the city's most valuable type of chemical product. ther leading chemical products include industrial ıemicals and pesticides. The chief processed foods oduced in Philadelphia include bakery products, bev-ages, and candy. The most important fabricated metal oducts are metal containers and sheet metal.

Transportation. Philadelphia International Airport ındles national and international flights. Local and re-onal airlines use the smaller Northeast Philadelphia rport. CSX Transportation and Norfolk Southern Rail-ay provide freight service to Philadelphia. Passenger ains link Philadelphia and cities throughout the coun-y. Four bridges link Philadelphia with New Jersey.

The publicly owned Southeastern Pennsylvania Trans-ɔrtation Authority provides most local transportation in e city. It operates buses, elevated and subway trains, reetcars, and trolley cars, and it administers commuter ilroad service.

Communication. Benjamin Franklin helped Philadel-ıia become a leading communication center of the merican Colonies. He published the *Pennsylvania azette,* a newspaper, from 1729 to 1766. Franklin also ublished *Poor Richard's Almanac,* a witty journal, every ːar from 1733 to 1758. The first magazine in America, *he American Magazine,* was published in Philadelphia 1741. The nation's first daily newspaper, the *Philadel-hia Evening Post and Daily Advertiser,* began publish-g in the city in 1783. Today, Philadelphia has two major daily papers, *The Philadelphia Inquirer* and *The Philadel-phia Daily News.*

Government

Until 1952, the city government of Philadelphia need-ed the approval of the Pennsylvania General Assembly to levy taxes and to act on many other local matters. That year, under a new charter granted by the state, the city gained *home rule* (self-government).

Philadelphia has a mayor-council form of government. The voters elect the mayor and the 17 members of the City Council to four-year terms. The mayor may serve any number of terms, but not more than two in a row.

Philadelphia's mayor has broad powers. The mayor appoints most of the city's chief administrative officials, plans improvement projects, prepares the city budget, and can veto laws passed by the council.

The council's chief duty is to make the city's laws. The council also decides how the city government spends its money. Any bill vetoed by the mayor becomes law if the council repasses it by a two-thirds vote.

Most of the city's income comes from taxes on prop-erty and wages. The city taxes the wages of everyone who either works or lives in Philadelphia. But taxes and other local sources of revenue do not meet all the city government's expenses. As a result, Philadelphia relies on grants from the state and federal governments to pay for many major improvements.

History

The Delaware Indians lived on the site of what is now Philadelphia long before Europeans arrived. British and Dutch sailors visited the area in the early 1600's. In the 1640's, Swedish families established the first permanent settlement there. The Dutch, English, and Swedes fought over the area, and England finally won control of it in 1674.

Early colonial days. In 1681, King Charles II of Eng-land granted William Penn a charter to establish what became the Pennsylvania Colony. Penn chose the site of Philadelphia for the capital, which he visualized as a

Harvey Lloyd, Black Star



Fairmount Park occupies both banks of the Schuylkill River and Wissahickon Creek in Philadelphia. It is the city's chief recreational area. The park includes Philadelphia's zoo, a Japanese teahouse, and six colonial mansions that visi-tors may tour.

"greene countrie towne." He arrived there in 1682, and the town became the capital of Pennsylvania in 1683.

Penn had advertised his guarantee of religious liberty before he left Europe, and thousands of persecuted people came to Philadelphia. The town also quickly acquired a reputation for offering economic opportunity. As a result, Philadelphia attracted thousands of other Europeans who were fleeing famine, poverty, or war. The Philadelphia area had a population of about 4,500 by 1700. Philadelphia was incorporated as a city in 1701.

Philadelphia's location near important land and water trading routes helped it become a prosperous manufacturing and shipping center. During the early 1700's, the city developed into the leading industrial center and busiest port in the American Colonies.

In 1723, a 17-year-old apprentice printer named Benjamin Franklin moved to Philadelphia from Boston. Within a few years, he had become Philadelphia's most famous civic leader. His newspaper and almanac helped make the city a major publishing center. By 1760, the Philadelphia area had a population of about 20,000. It was the largest city in the colonies.

The Revolutionary War period. Philadelphia became a center of colonial protest during the mid-1700's, when the United Kingdom adopted taxes and trade policies that angered the Americans. In 1774, the First Continental Congress met in Carpenters' Hall. Its delegates criticized British laws that they thought violated the colonists' rights. In May 1775, after the opening battles of the Revolutionary War, the Second Continental Congress assembled in the Pennsylvania State House (now Independence Hall). It adopted the Declaration of Independence there on July 4, 1776. Thomas Jefferson had written the Declaration in Philadelphia in June of that year. Congress met in the city during most of the war.

British troops captured Philadelphia on Sept. 26, 1777, shortly after winning the Battle of Brandywine. American forces tried to recapture the city, but the British defeated them in the Battle of Germantown on Oct. 4, 1777. In 1778, France joined the Americans in the war and sent a fleet to aid the colonists. On June 18, 1778, the British withdrew from Philadelphia to avoid being trapped there by the French fleet. Congress met in the city again from July 1778 until June 1783. Two Philadelphia financiers, Robert Morris and Haym Salomon, raised great amounts of money to aid the American effort in the Revolutionary War.

In 1787, delegates to the Constitutional Convention signed the Constitution of the United States in Independence Hall. Philadelphia served as capital of the United States from 1790 until 1800, when Washington, D.C., became the capital. By 1790, the population of the Philadelphia area had risen to about 42,000, the largest in the nation. In 1793, Philadelphia suffered one of its greatest disasters when a yellow fever epidemic killed almost 5,000 of its people. In 1799, the Pennsylvania legislature moved the state capital from Philadelphia to Lancaster, which served as the capital until Harrisburg was named the capital in 1812.

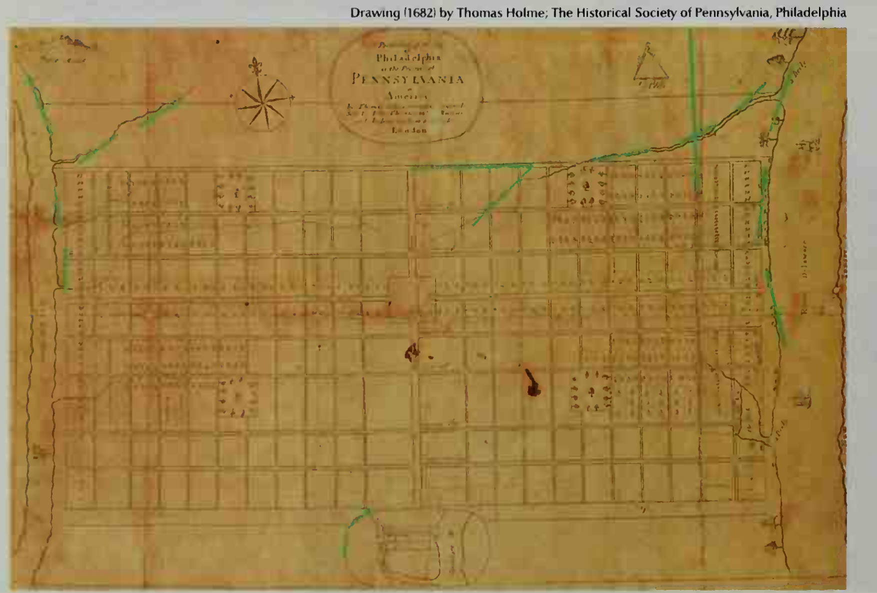
Industrial beginnings. During the early 1800's, the development of coal mines northwest of Philadelphia provided a huge fuel supply and helped attract industries to the city. The construction of canals, railroads, and roads increased trade between Philadelphia and the Midwest. Philadelphia industries produced clothing, iron, locomotives, machinery, ships, shoes, and textiles.

The city's rapid industrialization drew thousands of German and Irish immigrants to Philadelphia during the mid-1800's. Competition for jobs among the newcomers and those already in the city caused tension. In 1844, riots between native-born Protestants and Catholic immigrants from Ireland caused about 30 deaths. Many blacks were also killed in riots.

Eleven nearby towns became part of Philadelphia in 1854, when the state legislature merged the city and Philadelphia County. By 1860, the city had a population of 565,529.

During the mid-1800's, Philadelphia became a center of the antislavery movement. In 1833, the abolitionist reformer Lucretia C. Mott and other Philadelphians

Drawing (1682) by Thomas Holme; The Historical Society of Pennsylvania, Philadelphia



William Penn's plan for Philadelphia was drawn up in 1682. The plan covered a strip of land between the Schuylkill River on the west and the Delaware River on the east. This area is the present-day Center City. The square in the center is the site of City Hall.

rmed the American Anti-Slavery Society. Two black iladelphia businessmen, James Forten and Robert ırvis, became abolitionist leaders. During the Ameri- ın Civil War (1861-1865), a Philadelphia banker, Jay oke, was the Union's chief financial agent. The city's dustries boomed with the production of war materials.

A growing city. In 1876, Philadelphia held the Cen- nnial Exposition, a world's fair that marked the 100th ıniversary of the adoption of the Declaration of Inde- endence. The exposition was the first successful orld's fair in the United States.

Industry and commerce continued to expand in iladelphia during the late 1800's. Leading Philadelphia ısinessmen, including the financier Anthony J. Drexel ıd the merchant John Wanamaker, helped develop a owntown shopping district on Market Street. In the 390's, a system of electric trolley cars enabled many iladelphians to move far from the downtown area.

During the late 1800's and early 1900's, an increasing emand for factory workers attracted thousands of East- n European Jews and Italians to Philadelphia. African mericans from the Southern States began to migrate to e city in large numbers at the time of World War I 914-1918). Philadelphia's population soared from about 50,000 in 1880 to more than 1,800,000 in 1920. Thou- ınds of African Americans settled in Philadelphia dur- g and after World War II (1939-1945) in hope of finding bs and escaping racial violence. The city's population eaked at more than 2 million in 1950.

Urban renewal. Philadelphia launched a vast urban newal program in the late 1940's. The city cleared hun- reds of acres of residential and industrial structures. ne Penn Center, an office complex, rose west of City all in an area where there had once been railroad acks. In the mid-1950's, the program was expanded to ear space for hospitals, universities, and other institu- ons. With the help of the federal and state govern- ıents, the city tore down three entire blocks of old uildings north of Independence Hall and replaced em with a spacious landscaped area. The city built ublic housing projects to house the tens of thousands f poor Philadelphians who lost their neighborhoods uring these urban renewal efforts.

African American Philadelphians led by Leon H. Sulli- ın, minister of Philadelphia's Zion Baptist Church, be- an to develop a number of major economic self-help rojects in the 1950's. In 1964, Sullivan founded the Op- ortunities Industrialization Center to help train African mericans for jobs.

Continued growth. During the 1970's, developers unched several major projects in Center City. An en- osed shopping mall known as Gallery I opened in 1978 s part of the Market Street East development near City all. A second mall, Gallery II, opened in the early 1980's. ne Market Street East project also includes the massive ennsylvania Convention Center, which opened in 1993. ı 1986, a marina and a marine trade center were com- leted as part of the Penn's Landing complex on the elaware River. In 1991, the city created the Center City istrict, where businesses supported a successful effort clean up downtown.

In 1983, Philadelphia voters elected the city's first frican American mayor, W. Wilson Goode. Goode was elected in 1987. He served as mayor until 1992.

Recent developments. The end of the 1900's brought a reevaluation of the massive urban renewal that had taken place in the 1950's and 1960's. Critics pointed out that it had been wrong to move the poor into unattractive public housing projects. The city began tearing down most of the public housing high-rises.

Philadelphia turned to tourism to improve its economy. The city focused on promoting its matchless historical sites and institutions and encouraging new restaurants and hotels. Philadelphia became known for fine dining. Several new hotels opened for the Republican National Convention of 2000, which the city hosted. However, most of the area's highest paying jobs remained in the suburbs. Morris J. Vogel

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Outline

I. **The city**
   A. Downtown Philadelphia
   B. Residential districts
   C. The metropolitan area
II. **People**
   A. Ethnic groups
   B. Education
   C. Housing
   D. Social problems
III. **Cultural life and recreation**
   A. The arts
   B. Libraries and museums
   C. Recreation
IV. **Economy**
   A. Service industries
   B. Manufacturing
   C. Transportation
   D. Communication
V. **Government**
VI. **History**

Questions

Why was Philadelphia nicknamed the *Quaker City*?
What two famous documents were signed in the city?
What disaster struck Philadelphia in 1793?
Between which two rivers does downtown Philadelphia lie?
What three famous Revolutionary War sites lie within the city's metropolitan area?
Who founded Philadelphia? When?
What broad powers does Philadelphia's mayor have?
When was Philadelphia the nation's capital?
What Philadelphia school is the oldest art school in the United States?
Who helped Philadelphia become a leading communication center of the American Colonies?

Philadelphia, *FIHL uh DEHL fee uh,* was the name the ancient Greeks gave to several cities. The name means *brotherly love.* One Philadelphia was a town in Lydia founded in the 100's B.C. by King Attalus II Philadelphus of Pergamum. It was a center of early Christianity. Alaşehir, Turkey, stands on the site now. Another ancient Philadelphia, in Palestine, began as a city called Rabbath-Ammon. But the Egyptian king Ptolemy II Philadelphus conquered it, renamed it, and introduced Greek customs and culture. The capital of Jordan, Amman, stands on this site. Thomas W. Africa

Philadelphia Naval Base, Pennsylvania, houses major United States naval activities in the Philadelphia area. It covers 1,275 acres (516 hectares) along the banks of the Delaware River. Operations under the base's command include a damage control training center, a school for boiler-room crews, and an ammunition depot. A shipyard operated there from 1801 to 1996. The naval base also serves as Fourth Naval District headquarters. The district operates an air engineering center and a home for aged and disabled Navy veterans. W. W. Reid

Philanthropy, *fuh LAN thruh pee,* is the promotion of the well-being of human beings by individuals and groups who contribute their services or dedicate their property and money. Philanthropy differs from charity in that it usually helps a large group or an institution, rather than one or a few individuals.

Nearly all civilizations have practiced some type of philanthropy. The ancient Jews levied a *tithe* (tax) for the poor. In ancient Egypt and Greece, royal families gave gifts to establish libraries and universities. The medieval church supported hospitals and orphanages.

In Anglo-Saxon law, the legal basis of philanthropy rests on the Statute of Charitable Uses, passed in England in 1601. The statute approved governmental aid to poor, aged, and orphaned people. It also provided for assistance to hospitals, schools, and universities.

In the United States, gifts from private donors helped establish many early churches, colleges, and hospitals. For example, gifts helped create and support Harvard College. In 1790, Benjamin Franklin established a fund to aid worthy young men. In 1829, James Smithson set aside money for the creation of the Smithsonian Institution (see **Smithsonian Institution**).

Philanthropy has played an increasingly important role in U.S. society since the American Civil War. People of large fortunes, such as John D. Rockefeller and Andrew Carnegie, established foundations that have worked to better humanity nationally and internationally. The contributions of such people have set an example for the public, which contributes billions of dollars annually through benevolent and civic agencies. Joseph C. Kiger

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Other philanthropists

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Medici, Cosimo de'
Medici, Lorenzo de'
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Other related articles

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Philately. See **Stamp collecting.**

Philemon, *fuh LEE muhn,* **Epistle to,** is the 18th book of the New Testament. It is a letter from the apostle Paul to Philemon, a Christian associate of Paul. The apostle wrote the letter from prison, possibly in Rome, about A.D. 60. The letter was carried by Onesimus, a slave who had run away from Philemon, whom Paul was sending back to his owner. Paul asks Philemon not to punish Onesimus and seems to suggest that Philemon send Onesimus back to Paul to work with him. The Epistle is the shortest of Paul's letters. Terrance D. Callan

Philip II (1165-1223) of France was one of the most important kings of the Capetian dynasty, which ruled France from 987 to 1328. He succeeded his father, Louis VII, in 1180. A clever statesman, Philip not only expanded the kingdom of France but also made the monarchy powerful. He is also known as Philip Augustus.

Philip's first triumph was adding the regions now known as Artois and Picardy to his kingdom. He obtained Artois as part of his wife's *dowry* and Picardy as a result of a dispute with his wife's uncle, the Count of Flanders. A dowry is a wedding gift from the bride's family to the groom. Philip then decided to gain the English possessions in what is now France for himself. In 1189, Philip and the English king Richard the Lion-Hearted went together on the Third Crusade. But Philip quarreled with Richard and returned home. He took advantage of Richard's absence to gain control of some of the English territory in France.

In 1194, Richard returned from the crusade and began a war against Philip in which Richard regained control of most of the English lands in France. Richard was killed in battle in 1199. His brother, King John, went to war against Philip in 1202. Philip took advantage of John's mistakes and conquered most of the English holdings in France. Philip's victory against John's Flemish and German allies at the Battle of Bouvines in 1214 established his hold on the conquered regions.

Granger Collection
Philip II of France

Philip then held greater powers than any of his strongest barons, and he carried out a series of governmental reforms to strengthen his authority. These reforms laid the basis for the later rule of the French kings. Philip was born in Paris. Sue Helder Goliber

Philip II (382-336 B.C.) was a great Macedonian king who became master of Greece. He was the father of Alexander the Great, who carried out many of his father's

eams of conquest. See **Alexander the Great.**

Philip, the youngest son of Amyntas II, was born in la. In his early youth, he spent several years as a stage in Thebes. While in Thebes, Philip learned ich of military science from the foremost military ders of the time.

Philip was named regent for his nephew in 359 B.C. en his older brother died. But Philip soon made him-f king. Within two years, he put down all opposition d established himself securely on the throne.

Philip immediately began to carry out his plans of nquest by attacking the Greek towns on his border. had reorganized the Macedonian army so that it was perior to the Greek armies. He used the heavy phalanx mation of attack as a striking arm and heavy cavalry the knockout blow. He developed the light infantry d light cavalry and used them in an all-out pursuit ich destroyed his opponents. Within a few years, ilip controlled most of the small states in Greece. His wer extended as far north as the Danube River.

n Athens, Demosthenes understood Philip's plans, d he thundered forth against Philip in his famous eeches, which came to be known as the *Philippics.* t the Athenians refused to listen to Demosthenes. ey did not believe Philip was a threat to Athens, be-use he was at war with Thrace at the time. In 338 B.C., mosthenes was finally able to rouse the Athenians, d they joined with Thebes in a defensive league ainst Philip. But the Macedonian king completely de-ted the allied armies in the battle Chaeronea that me year, and ended the independence of the Greek y-states.

Philip formed Greece into the League of Corinth, a po-cal organization. All the cities were included except arta, which had never been conquered. The cities re represented in the *Synhedrion* (council) by popula-n and districts. Non-Greek nations were allowed to n. Philip was chosen by the League to command the Greek forces to attack Persia. He was killed while preparing for this war. Thomas W. Africa

See also **Demosthenes; Macedonia** (Historical region); **Olympias.**

Philip II (1527-1598) was a Spanish king who ruled one of the largest empires ever created. He belonged to the Habsburg (or Hapsburg) royal family. In 1555 and 1556, Philip's father—who ruled Spain as Charles I and the Holy Roman Empire as Charles V—gave up his crowns. Philip became king of Spain and ruler of lands that included what are now Belgium, the Netherlands, part of Italy, and much of Central and South America.

Philip spent much of his reign at war defending his empire. Spain, Venice, and their allies defeated the Ottoman fleet at the Battle of Lepanto, near Greece, in 1571. Philip absorbed Portugal into Spain in 1580. But the Netherlands, one of Spain's most valuable possessions, rebelled in the 1560's and declared its independence in 1581. England aided the Dutch rebels. Sir Francis Drake and other English captains also looted Spanish possessions in Central and South America. Philip assembled a fleet of ships so powerful that it was called the Invincible Armada and sent it against England in 1588. The Armada failed to achieve its goals. Philip's many wars strained Spain's resources and contributed to its slow decline in the 1600's.

Philip considered himself the champion of the Roman Catholic faith and strongly supported the Inquisition, which punished Christians accused of holding views opposed to those of the church. He also built El Escorial, a palace and religious center near Madrid.

Philip was born on May 21, 1527, at Valladolid, Spain. The Philippine Islands, where Spain established a colony in 1565, were named after him. Marvin Lunenfeld

See also **Escorial; Mary I; Spanish Armada.**

Philip IV (1268-1314) of France succeeded his father, Philip III, as king in 1285. Philip IV was called "the Fair" because he was considered handsome.



Ivory miniature carving (about 350-325 B.C.); Granger Collection

lip II was a great Macedonian king. He had conquered much Greece before he was assassinated in 336 B.C.



Detail of an illuminated French manuscript (about 1450) (Granger Collection)

Philip IV, *left,* received the homage of King Edward I of England, *kneeling,* in 1286, a year after Philip became king of France.

Philip challenged the power of Pope Boniface VIII in 1301 by arresting a French bishop whom Boniface had appointed. In 1302, Philip taxed Roman Catholic churches against the pope's orders. Philip's actions were approved by the first Estates-General, a body of Frenchmen he called together in 1302. This group, which included representatives of the clergy, nobility, and middle class, was the ancestor of the French Parliament. Philip had Boniface arrested at Anagni, Italy, in 1303. But the townspeople freed the pope. In 1305, Philip arranged the election of a French archbishop as pope. The new pope, Clement V, moved to Avignon, France, in 1309 and carried out Philip's orders, which included persecuting the Knights Templars, a wealthy military order with strong ties to the papacy. Philip was born in Fontainebleau, France. Sue Helder Goliber

See also **Boniface VIII; Knights Templars.**

Philip V (1683-1746) became king of Spain in 1700. He was the first in a series of Spanish kings from the royal Bourbon family of France. Philip was born a French prince, Duke Philip of Anjou, in Versailles, France. He inherited the throne of Spain from his grandmother's brother, Charles II, who died childless. Other nations feared French control of the Spanish throne and refused to recognize Philip as king. In 1701, Austria, England, the Netherlands, and several German states declared war on France and Spain, and the War of the Spanish Succession began. Philip finally won recognition as king in 1713, but he lost many of his territories to Austria and Britain (see **Succession wars** [The War of the Spanish Succession]). Philip gave up the throne to his son Louis I for eight months in 1724 but returned after Louis died. Philip then ruled until 1746. Marvin Lunenfeld



Detail of an oil painting on canvas (1819) by Jean Auguste Dominique Ingres; collection of the Duchess of Alba, Madrid, Spain (SCALA/Art Resource)

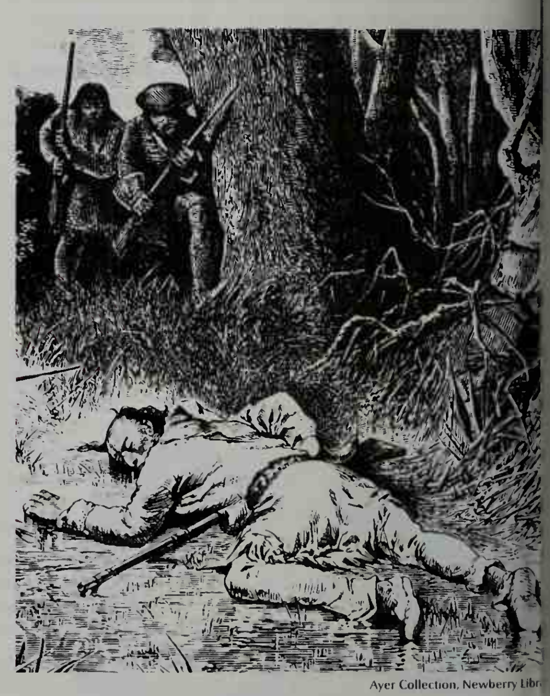
Philip V was the first Bourbon king of Spain. This painting shows him awarding a decoration to a French military leader who served him.

Philip VI (1293-1350) of France became the first of the Valois line of French kings in 1328. An assembly of barons and church officials chose Philip, a nephew of Philip IV, after Charles IV, the last king of the Capetian dynast had died without leaving a male heir. During Philip's reign, relations with England became hostile. In 1337, Philip declared he would take over Guyenne (Aquitain the land King Edward III of England held in France. Edward III, in turn, a grandson of Philip IV of France, claimed the French throne. These actions began the Hundred Years' War. Philip lost several battles in the war, including an important one at Crécy in 1346. Whe the war ended in 1453, more than a hundred years late the French had driven the English out of almost all of France. A plague epidemic called the Black Death deva tated France in the last few years of Philip's reign. See also **Dauphin; Hundred Years' War.** Sue Helder Golibe

Philip, King (? -1676), became chief of the Wampanoag Indians in 1662. His Indian name was Metacomet. He was the son of Massasoit, the Pilgrims' friend. Philip succeeded his older brother as chief.

As Philip saw the increasing amounts of land taken b the settlers, he grew concerned that the colonists wou in time destroy his people. Soon after he became chief he began preparations to massacre all the white settler in New England. The great struggle known as King Phil ip's War began in 1675. Philip burned both white and In dian settlements. Men, women, and children were kille on both sides. King Philip almost succeeded in wiping out the English settlements in New England. But after the defeat of his forces by the English colonists, Philip was hunted down and killed in a swamp near present-day Bristol, R.I., in 1676. The war then ended in souther New England, but fighting continued in northern New England until 1678. William H. Gilbert

See also **Indian wars** (King Philip's War); **Massasoit.**



Ayer Collection, Newberry Libr

King Philip was hunted down and killed in a swamp by a grou of colonists and their Indian allies.



British Information Services

nce Philip often represents Queen Elizabeth at affairs of te. He also accompanies her on royal tours of countries in the tish Commonwealth of Nations.

ilip, Prince (1921-), is the husband of Queen zabeth II of the United Kingdom of Great Britain and rthern Ireland. His full title is His Royal Highness The nce Philip, Duke of Edinburgh, Earl of Merioneth, on Greenwich.

Prince Philip was born on the Greek island of Corfu June 10, 1921. His father, Prince Andrew of Greece, s the fourth son of King George I of Greece. Philip's ther, Princess Alice of Battenberg, was a great-inddaughter of Queen Victoria of Britain and the sis- of the British military leader Louis Mountbatten.

Philip was educated in France, Germany, and Britain. attended Gordonstoun school in Scotland and the yal Naval College in Dartmouth. During World War II 39-1945), he served as a lieutenant in the British Navy h the Mediterranean and the Pacific fleets.

n 1947, Philip gave up his succession to the throne of eece. He became a British citizen, taking Mountbatten his last name. He married Princess Elizabeth on Nov. 1947. Her father, King George VI, made Mountbatten ke of Edinburgh the day before the wedding. Eliza-h became queen in 1952. In 1957, she gave her hus-d the title of Prince of the United Kingdom. The cou- have four children (see **Elizabeth II**).

s *prince consort* (husband of the queen), Prince lip has no formal role in government. He performs lic duties in Britain and the Commonwealth of Nations as a representative of the British Crown. He also accompanies Queen Elizabeth on tours and visits.

Prince Philip's interests include technological research and industry, especially their effect on living conditions and the environment. In 1961, he became president of the British branch of the World Wildlife Fund (now the World Wide Fund for Nature). In 1981, he became the group's international president. Prince Philip, a well-known public speaker, has published collections of his speeches, including *Down to Earth* (1988). He also enjoys boating and flying. Richard Rose

Philip of Anjou. See Philip V (of Spain).

Philip of Bethsaida, *behth SAY ih duh,* **Saint,** was one of the 12 apostles of Jesus Christ. He is prominent in the Gospel of John and was one of the first to be called as an apostle. He was present at the miracle of the feeding of the multitude (John 6: 5-7). When a group of Greeks wanted to see Jesus, they approached Philip for an introduction (John 12: 20-22). At the Last Supper, Philip asked to see the Father. Jesus replied, "He that hath seen me hath seen the Father" (John 14: 8, 9). This special interest in Philip indicates that he was highly regarded by the author of the Gospel of John. Philip should not be confused with Philip the Evangelist, who is mentioned in the Acts of the Apostles.

According to later tradition, Philip preached in Asia Minor (now Turkey), where he was martyred. Philip's feast day in the Roman Catholic Church is May 3. The Eastern Orthodox Churches celebrate his feast day on November 14. Richard A. Edwards

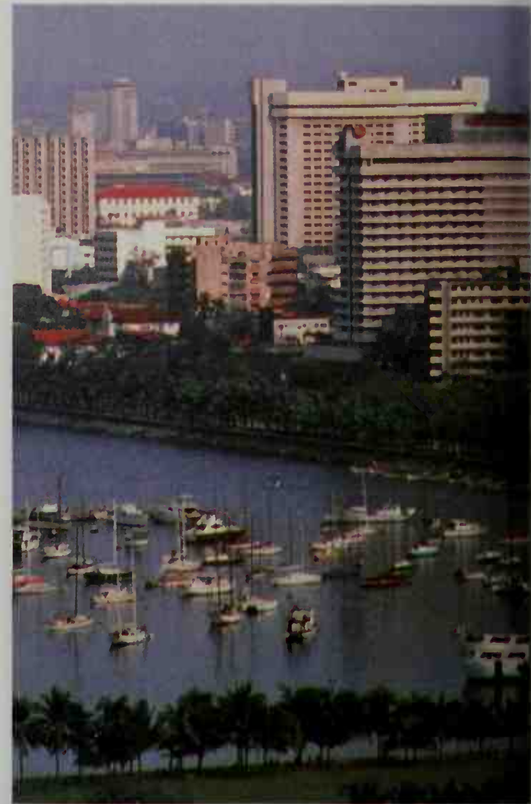
See also **Apostles**.

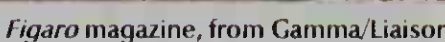
Philip the Evangelist, *ih VAN juh lihst,* was an early Christian. He is listed in the Acts of the Apostles as a deacon chosen by the apostles to assist with practical activities of the early church in Jerusalem. He should not be confused with Philip the Apostle, one of the 12 apostles. According to Acts, Philip worked in Judea and Samaria. Later tradition says he was the bishop of Tralles in Turkey. Philip's feast day is June 6 in the West and October 11 in the East. Richard A. Edwards

Philippi, *FIHL uh PY* or *fih LIHP eye,* was a city in Macedonia. It stood about 8 miles (13 kilometers) from the Aegean coast, near what is now the Greek city of Kavalla. King Philip II of Macedon founded Philippi in 357 B.C. The city became an important gold-mining center. Mark Antony and Octavian (later Augustus) defeated two of Julius Caesar's assassins, Brutus and Cassius, at Philippi in 42 B.C. Octavian later made Philippi a colony for Antony's supporters who had been expelled from Italy. Philippi was the first city in Europe to be visited by St. Paul. It flourished until about A.D. 600. See also **Philippians, Epistle to the.** Clive Foss

Philippians, *fuh LIHP ee uhnz,* **Epistle to the,** is the 11th book of the New Testament. It is a letter from the apostle Paul to the Christians in Philippi in what is now northern Greece. Many scholars doubt that Paul wrote the letter in its present form. They believe it consists of three smaller letters from Paul to the Philippians that were combined by a later editor. If Paul wrote the letter in its present form, he did so while in prison, probably in Rome, about A.D. 60. In the Epistle, Paul thanks the Philippians for sending him money. He warns them not to observe the Jewish law and urges them to be at peace with one another. Terrance D. Callan







© Philip Jones Griffiths, Mag

Traditional and modern ways of life contrast greatly in the Philippines. In northern Luzon, farmers grow crops on mountain terraces said to have been built more than 2,000 years ago by Malay immigrants. In Manila, the capital and largest city, modern buildings rise above a bay.

Philippines

Philippines is an island country in the southwest Pacific Ocean. Its official name is Republic of the Philippines. The Philippines consists of more than 7,000 islands, but only about 1,000 of them are inhabited. The 11 largest islands make up more than 95 percent of the country's area. Manila, the capital of the Philippines, is the nation's largest city and busiest port.

The people of the Philippines are called *Filipinos.* Their ancestors came from what are today Indonesia and Malaysia. Groups of these people formed communities throughout the islands, and each group developed its own culture. As a result, the Philippines has a wide variety of languages, customs, and ways of life.

Spanish explorers colonized the Philippines in the 1500's. They named the islands after King Philip II of Spain. Roman Catholic religious missionaries converted most of the Filipinos to Christianity, but some tribes kept their own religions. Today, the Philippines has more Christians than any other nation of Asia.

James Putzel, the contributor of this article, is Director of the Development Research Centre at the London School of Economics and Political Science.

In 1898, Spain gave the Philippines to the United States as part of the treaty that ended the Spanish-Am ican War. Filipino nationalists attempted to gain inde- pendence for the islands, but the United States stopp the rebellion and ruled the islands until the Philippine became a self-governing commonwealth in 1935. Fron

Facts in brief

Capital: Manila.
Official languages: Filipino and English.
Official name: Republic of the Philippines.
Area: 115,831 mi² (300,000 km²). *Greatest distances*—north-sou 1,152 mi (1,854 km); east-west, 688 mi (1,107 km). *Coastline*— 10,900 mi (17,500 km).
Elevation: *Highest*—Mount Apo, 9,692 ft (2,954 m) above sea level. *Lowest*—sea level.
Population: *Estimated 2002 population*—78,850,000; density, 6 per mi² (263 per km²); distribution, 53 percent rural, 47 perc urban. *2000 census*—76,498,735.
Chief products: *Agriculture*—bananas, cassava, coconuts, co hogs, pineapples, rice, sugar cane, sweet potatoes. *Forestr* ebony, kapok, Philippine mahogany. *Fishing industry*—milk fish, mother-of-pearl, scad, shrimp, sponges, tuna. *Mining*- chromite, copper, gold, nickel. *Manufacturing*—cement, chemicals, clothing, electronic equipment, foods and beve ages, petroleum products, textiles, wood products.
Money: *Basic unit*—peso. One hundred sentimos equal one peso. See also Peso.



© Francis Lochon, Gamma/Liaison

Good Friday procession in Manila draws an enormous ɔwd. Almost all the people of the Philippines are Christians, ɔst of them Roman Catholics.

42 to 1944, during World War II, Japanese forces con- ɒlled the islands. The United States granted the Philip- nes independence on July 4, 1946. The new nation opted a Constitution that was similar to that of the nited States. The Philippines struggled to establish a ıble government through much of the late-1900's.

Government

National government is headed by the president. e people elect the president and vice president sepa- ely. The president is limited to one six-year term and e vice president to two consecutive six-year terms. The ngress consists of a Senate and a House of Repre- ntatives. The Senate has 24 members, who are elected six-year terms by the voters of the entire nation. The use has a maximum of 254 members. Voters from dis- cts elect 204 of the representatives to three-year rms. The remaining 50 representatives are selected m lists drawn up by political parties and civic organi- ions to ensure representation of women, ethnic mi- rities, and certain economic and occupational groups. citizens who are at least 18 years old may vote.

Local government. The Philippines is divided into 16 gions, each governed by a regional council. The re- ns are divided into a total of 79 provinces. Every ɔvince has a governor, a vice governor, and a provin- l council. These officials are elected by the people and serve three-year terms.

There are about 60 *chartered cities* in the Philippines. These cities, headed by elected mayors, are governed independently of the provinces. The nation also has about 1,500 *municipalities* (towns). Each municipality is governed by an elected mayor and a council. The Philippines has about 42,000 *barangays* (villages), governed by captains and councils elected by each village.

Courts. The Supreme Court is the highest court in the Philippines. It consists of a chief justice and 14 associate justices. The president appoints all judges.

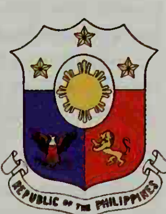
The Court of Appeals, which reviews decisions made by lower courts, consists of a presiding justice and 50 associates. Every Philippine city has a court. Each municipality has a judge who serves as the local court.

Armed forces. The Philippine Army has about 67,000 members, all volunteers. A navy of 24,000 people and an air force of 16,000 also consist of volunteers. The Philippine National Police has over 100,000 members in a variety of agencies. It cooperates with the armed forces to maintain internal security.

The people

Ancestry. Almost all Filipinos are related to the Malays of Indonesia and Malaysia. Chinese make up the





The Philippine flag and coat of arms feature blue for noble ideals, red for courage, and white for peace. The sun represents independence, and the stars stand for the three main groups of islands. Former Western rule is symbolized on the coat of arms by an eagle representing the United States and a lion representing Spain. The flag was adopted in 1898, and the coat of arms was adopted in 1946.



WORLD BOOK map

The Philippines lies in the Pacific Ocean off the Southeast Asian mainland. It consists of more than 7,000 islands.



Artstreet

A residential suburb is part of the huge metropolitan area of Manila. The Manila metropolitan area is one of the largest in the world.

second largest group in the Philippines, and smaller numbers of Americans, Europeans, Indians, and Japanese also live on the islands. All of these groups have contributed to the Philippine culture, a blend of Asian and Western traditions.

Small groups of Filipinos live in isolated mountain areas. These small groups include the Negritos, whose ancestors settled in the islands about 30,000 years ago.

Languages. The Philippines has two official languages, Filipino (also spelled Pilipino) and English. Filipino is the national language, and it is a required subject in all Philippine elementary schools. Filipino is a variation of Tagalog (pronounced *tah GAH lohg* or *tah GAH log),* the language of the people of the Manila area. More than half the people of the Philippines speak Filipino, and a large number also use Tagalog. About 70 native languages, all of them related to Malay languages, are also spoken in the Philippines.

Almost three-fourths of the people in the Philippines speak some English. The elementary schools and high schools conduct many classes in English, and the universities require students to pass an English examinatio[n] when applying for admission. English is also widely used in commerce and government. In addition, a smal[l] number of Filipinos speak Spanish or Chinese.

Way of life. About 40 percent of the Philippine work[ers] make their living by farming. Much of the farmland belongs to large and medium sized landowners. These owners hire laborers who live and work on the land. Large numbers of people also have jobs in the fishing, lumbering, and mining industries. In the cities, many work in factories or in the service sector.

Most houses in the rural areas stand close together i[n] small clusters. They have wooden walls, and the roofs are made of thatch or corrugated iron.

Wealthy city families live in large houses that are sur[-]rounded by walls. Government-built housing projects are common in the cities. Many poor urban people live

Cameramann International, Ltd.



A fishing village has small houses that stand close together. Fishing is an importa[nt] industry in the Philippines. Anchovies, mackerel, sardines, scad, tuna, and other fishes are caught in the wat[ers] surrounding the country's is[-]lands.



©Robert Frerck

blic elementary schools provide six years of free education for Philippine children. The Filnos value education highly, and about 25 percent of the people go to college.

roughly constructed shacks in sprawling slums.
Most Filipinos have large families and maintain a se relationship with all family members, including elr relatives and distant cousins. Men hold most positins of authority at home and in business. But many men work in professional fields. A growing number women work in textile or electronic factories.
Philippine food is a mixture of American, Chinese, alay, and Spanish dishes. Most Filipinos eat rice at ery meal, with beef, fish, or poultry, if they can afford eat. Each region has its own specialties. One popular h, called *adobo,* consists of chicken and pork cooked soy sauce and vinegar. People throughout the islands nk an alcoholic beverage called *tuba,* which is made m the sap of the coconut palm tree.
Most Filipinos wear clothes similar to those worn in st Western countries. On holidays and other special casions, Philippine men wear a *barong tagalog,* a autifully embroidered shirt made of pineapple fiber, v silk, or cotton. Some men wear the barong tagalog work in offices. On special occasions, women may ar a long, puff-sleeved dress called a *balintawak.*
Basketball is one of the most popular sports in the lippines. Other favorite sports include baseball, boxi, and, among the wealthy, golf. Many Filipinos enjoy mbling, much of which is legal in the Philippines. Othpopular recreational activities include *karaoke* ging on stage to recorded music) and movies.

Religion. The Philippine Constitution guarantees freem of worship. About 95 percent of the people are ristians, more than in any other Asian country. Over percent of the population are Roman Catholics. The ion also has many Protestants, Muslims, and mems of the Philippine Independent Church and the lippine Church of Christ.

Education. About 90 percent of Philippine adults can d and write. The law requires children from 7 to 12 rs old to go to school through at least the sixth de. Teachers in the public elementary schools conduct classes in the local language for the first two years and then introduce English and Filipino. Most private schools, high schools, and universities teach in English.
About 25 percent of college-age Filipinos attend college, mostly at private or religious schools. The University of the East, a private institution in Manila, is the nation's largest university.

The arts. The Philippines has produced many painters and writers. Fabian de la Rosa, a popular Philippine artist of the 1800's, painted works showing the everyday life of the people. Fernando Amorsolo, who studied under de la Rosa, became known in the 1900's for his portraits and rural landscapes.
Early Philippine literature consisted mainly of native legends and poems. During the late 1800's, Philippine



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Brightly decorated taxis called *jeepneys* furnish inexpensive transportation in cities throughout the Philippines. These vehicles were originally made from World War II jeeps.

writers began examining the heritage of the islanders. Literature played an important part in the Philippine movement for independence in the late 1800's and early 1900's. José Rizal, an early leader of the movement, wrote novels that criticized Spanish authority in the Philippines. The essays of Renato Constantino center on modern Filipinos and their search for a national identity.

Land and climate

Thick forests once covered most of the Philippines. But since the 1950's, extensive lumbering has destroyed most of the forest resources. Narrow strips of lowland lie along the coasts of the islands. The islands of Luzon and Panay have wide inland plains. Volcanic mountains rise on most of the country's larger islands, and many of the volcanoes are active. The highest mountain, Mount Apo on Mindanao, towers 9,692 feet (2,954 meters) above sea level. Violent earthquakes occur frequently.

The Philippines has many fine bays and harbors. Large lakes include Laguna de Bay on Luzon and Lake Sultan Alonto on Mindanao. Most of the rivers flow only in the rainy season, from June to February. The Philippine Trench, one of the deepest spots in all the oceans, is off the northeast coast of Mindanao. It is 34,578 feet (10,539 meters) below the surface of the Pacific.

A wide variety of plants and animals live in the Philippines. Banyan and palm trees grow in the forests. Thick groves of bamboo and about 9,000 other kinds of flowering plants grow throughout the islands. Wild animals of the Philippines include crocodiles, monkeys, snakes, and many species of tropical birds. Tarsiers—small mammals with owllike eyes—live only in the Philippine and the East Indies. The chief domestic animal in the Philippines is the carabao, a type of water buffalo that farmers use to pull plows and do other heavy work.

The main islands. The Philippine Islands extend 1,152 miles (1,854 kilometers) from north to south and 688 miles (1,107 kilometers) from east to west. The islands form three groups. The northern group consists two large islands, Luzon and Mindoro. The central group, called the Visayan Islands, is made up of about 7,000 islands. The southern group consists of Mindana and the Sulu Archipelago, a group of about 400 islands that extend south and west toward Borneo. This sectior describes the 11 largest islands of the Philippines. The islands are listed in order of size.

Luzon, *loo ZAHN* (area 40,420 square miles, or 104,6 square kilometers), in the northern group, is the most important island. Manila lies on the southwest coast. Luzon produces most of the nation's rice and tobacco. It also has deposits of copper, gold, and other minerals.

Mindanao, *MIHN dah NOW* or *MIHN dah NAH oh* (area 36,537 square miles, or 94,630 square kilometers), is at the southeastern end of the Philippines. The country's highest mountains, including some active volcanoes, a on this island. Mindanao is one of the world's leading producers of *abacá* (Manila hemp). The leaves of the abacá plant contain a strong fiber, which the Filipinos

Philippines map index

Cities and towns‡

City	Population	Map key
Agoo	51,923	D 3
Angeles	263,971	D 3
Aparri	59,046	B 4
Bacarra	29,668	B 3
Bacolod	429,076	H 5
Bacoor*	305,699	E 3
Bago*	141,721	H 5
Baguio City	252,386	D 3
Bais	68,115	H 5
Balanga	71,088	C 6
Balimbing*	33,315	K 3
Balingasag	51,782	I 6
Bambang	41,393	A 7
Bangued	38,965	C 3
Bantayan	68,125	G 5
Basco*	6,717	A 4
Basilan (Isabela)	73,032	J 4
Batangas	247,588	E 4
Bayawan	101,391	H 5
Baybay	95,630	G 6
Bayombong	50,563	D 4
Binalbagan	58,280	H 5
Boac	48,504	F 4
Bogo	63,869	G 5
Bongabon	49,255	F 4
Bontoc	22,308	C 3
Borongan	55,141	G 6
Bulan	82,688	F 5
Butuan	267,279	I 6
Cabadbaran	55,006	H 6
Cabanatuan	222,859	D 3
Cadiz	141,954	G 5
Cagayan de Oro	461,877	I 6
Calamba	281,146	C 7
Calapan	105,910	F 4
Calbayog	147,187	F 6
Caloocan	1,177,604	C 6
Camiling	71,598	A 6
Canlaon*	46,548	H 5
Carcar	89,199	H 5
Carigara	43,455	G 6
Catarman	67,671	F 6
Catbalogan	84,180	G 6
Cavite	99,367	F 3
Cebu City	718,821	H 5
Cotabato	150,450	J 5
Daet	80,632	E 5
Dagupan	130,328	D 3
Danao	98,781	H 5
Dapitan	68,178	I 5
Daraga*	101,031	F 5
Datu Piang	67,303	J 6
Davao	1,147,116	J 6
Digos	125,171	J 6
Dipolog	99,862	I 5
Dumaguete	102,265	H 5
Enrile	29,062	C 4
Gapan	89,199	B 6
General Santos	411,822	K 6
Gingoog	102,379	I 6
Gubat	52,707	F 5
Guimba	87,295	D 3
Guiuan	38,694	G 6
Iba	34,678	D 3
Ilagan	119,990	C 4
Iligan	285,061	I 6
Iloilo	365,820	G 4
Iriga	88,893	F 5
Isulan*	73,129	J 6
Jolo*	87,998	K 3
Jose Pañganiban	46,064	E 4
Kalibo	62,438	G 4
Kidapawan*	101,205	J 6
Koronadal	133,786	J 6
Laoag	94,466	B 3
Laoang	54,523	F 6
Lapu-Lapu*	217,019	H 5
La Trinidad*	67,963	D 3
Lebak	70,899	J 5
Legazpi	157,010	F 5
Lemery	66,528	D 6
Lianga	25,014	I 7
Libmanan	88,476	E 5
Lingayen	88,891	D 3
Lipa	218,447	E 4
Lucban	38,834	C 7
Lucena	196,075	E 4
Maasin	71,163	H 6
Magallanes	31,315	F 5
Maganoy*	49,531	J 6
Makati*	444,867	E 4
Malabang	33,177	I 5
Malabon	338,855	D 3
Malalag	33,334	J 6
Malaybalay	123,672	I 6
Malita*	100,000	J 6
Malolos	175,291	E 3
Mambajao*	30,806	H 6
Mandaluyong*	278,474	E 4
Mandaon	31,572	F 5
Mandaue*	259,728	H 5
Manila	1,581,082 †9,932,560	E 3
Marawi	131,090	I 6
Marikina*	391,170	E 4
Masbate	71,441	F 5
Mati	105,908	J 7
Midsayap*	105,760	J 5
Muñoz	65,586	A 6
Muntinglupa	379,310	C 7
Naga	137,810	F 5
Nasugbu	96,113	E 3
Navotas*	230,403	E 3
Olongapo	194,260	E 3
Ormoc	154,297	G 6
Oroquieta	59,843	I 5
Ozamiz	110,420	I 5
Paete§	14,733	C 7
Pagadian	142,515	I 5
Palayan	31,253	B 7
Palompon	50,754	G 6
Paniqui	78,883	A 6
Parañaque*	449,811	E 3
Pasay	354,908	E 4
Pasig	505,058	C 7
Pili*	67,393	E 5
Pinamalayan	72,951	F 4
Prosperidad	70,815	I 7
Puerto Princesa	161,912	H 2
Quezon	41,669	H 2
Quezon City	2,173,831	E 4
Rizal	48,166	A 7
Roxas	48,929	C 4
Roxas	126,352	G 5
Sagay*	129,765	G 5
San Antonio	28,248	E 3
San Carlos	154,264	D 3
San Carlos	118,259	H 5
San Fernando*	102,082	D 3
San Fernando	221,857	B 6
San Jacinto	24,780	F 5
San Jose	108,254	A 6
San Jose	111,009	F 4
San Jose	48,261	G 4
San Juan del Monte*	315,807	E 4
San Marcelino	25,440	B 6
San Miguel*	123,824	B 6
San Pablo	207,927	E 4
Santa Cruz	92,694	C 7
Silay	107,722	G 5
Sindañgan	80,133	I 5
Siquijor	21,150	H 5
Solano	52,391	C 4
Sorsogon	92,512	F 5
Surigao	118,534	H 6
Tabaco	107,166	F 5
Tabuk*	78,633	C 4
Tacloban	178,639	G 6
Tagaytay	45,287	C 6
Tagbilaran	77,700	H 5
Tagum	179,531	J 6
Tandag	44,327	H
Tangub*	49,695	I
Tanjay	70,169	H
Tarlac	262,481	D
Taytay*	198,183	A
Tayug	36,199	A
Toledo	141,174	H
Trece Martires	41,653	C
Tuguegarao	120,645	C
Urdaneta	111,582	A
Valenzuela*	485,433	E
Vigan	45,143	C
Virac	57,067	F
Zamboanga	601,794	J

Physical features

Feature	Map key
Agno River	A 6
Agusan River	I 6
Babuyan Islands	B 4
Batan Islands	A 4
Basilan Island	J 4
Bataan Peninsula	C 6
Biliran Island	G 5
Bohol (Island)	H 5
Cagayan River	C 4
Calamian Group	G 3
Camiguin Island	H 6
Canlaon Volcano	H 5
Catanduanes Island	E 5
Cebu (island)	G 5
Celebes Sea	K 4
Cordillera Central (mountains)	C 3
Corregidor Island	C 6
Jolo Island	K 4
Laguna de Bay (lake)	C 7
Lake Mainit	H 6
Lake Sultan Alonto	I 6
Lake Taal	C 6
Leyte (island)	H 6
Lubang Islands	E 3
Luzon (island)	D 4
Luzon Strait	A 3
Magat River	C 4
Manila Bay	E 3
Marinduque (island)	F 4
Masbate (island)	G 5
Mayon Volcano	F
Mindanao (island)	I
Mindoro (island)	F
Mount Apo	J
Mount Halcon	F
Mount Mantalingajan	I
Mount Pinatubo	B
Mount Pulog	D
Mount Ragang	I
Mount Santo Tomas	A
Negros (island)	H
Palawan (island)	H
Pampanga River	B
Panay (island)	G
Philippine Sea	E
Philippine Trench	H
Polillo Islands	E
Pulangi River	J
Samar (Island)	G
Sierra Madre (mountains)	C
Siquijor Island	H
South China Sea	E
Sulu Archipelago	K
Sulu Sea	I
Tawitawi Group	K
Visayan Islands	G
Zambales Mountains	B
Zamboanga Peninsula	I

*Does not appear on the map; key shows general location.
†Population of metropolitan area, including suburbs.
‡Includes chartered cities and municipalities.
Source: 2000 census, except for §, where figures are for 1984.



hilippines
International boundary
Road
Railroad
Capital
City or town
Elevation above sea level
ORLD BOOK map
Luzon Strait
BATAN ISLANDS
Balintang Channel
BABUYAN I
CALAYAN I
BABUYAN ISLANDS
DALUPIRI I
FUGA I
CAMIGUIN I
Babuyan Channel
Escarpada Point
Bacarra
Aparri
Laoag
CORDILLERA CENTRAL
Bangued
Enrile
Tuguegarao
Vigan
Palanan Point
Bontoc
Roxas
Ilagan
SIERRA MADRE
Mount Pulog 9,606 ft. (2,928 m)
Solano
Lingayen Gulf
Baguio City
Bayombong
LUZON
Agoo
Dagupan
Cape San Ildefonso
Lingayen
San Carlos
Cape Encanto
Gumba
Tarlac
Cabanatuan
Dingalan Bay
SCARBOROUGH SHOAL
Iba
Angeles
San Antonio
Mt. Pinatubo
Malolos
POLILLO ISLANDS
Olongapo
Quezon City
AREA OF INSET MAP
Manila
Lamon Bay
Pasay
Jose Panganiban
San Miguel Bay
South China Sea
Manila Bay
Cavite
Nasugbu
San Pablo
Lucena
Daet
Yog Point
Lipa
LUBANG ISLANDS
Batangas
Tayabas Bay
Libmanan
CATANDUANES I
Naga
Iriga
Virac
Lagonoy Gulf
Calapan
Boac
Tabaco
Philippine Sea
Cape Calavite
MARINDUQUE
Mayon Volcano 7,943 ft. (2,421 m)
Mt. Halcon 8,481 ft. (2,585 m)
Pinamalayan
Sorsogon
BURIAS I
Legazpi
PHILIPPINES
MINDORO
Sibuyan Sea
Magallanes
Gubat
Bongabon
San Jacinto
Bulan
Laoang
Tablas Strait
Catarman
San Jose
TABLAS I
SIBUYAN I
TICAO I
BUSUANGA I
Mindoro Strait
Mandaon
Masbate
Calbayog
CALAMIAN GROUP
MASBATE
Samar Sea
SAMAR
CULION I
SEMIRARA ISLANDS
Potol Point
VISAYAN ISLANDS
Catbalogan
Linapacan Strait
Kalibo
Roxas
Visayan Sea
BILIRAN I
Borongan
LINAPACAN I
Carigara
Bantayan
Bogo
Tacloban
CUYO ISLANDS
PANAY
Cadiz
Palompon
Ormoc
Guiuan
Taytay Bay
Iloilo
CEBU
Leyte Gulf
San Jose
Silay
Baybay
HOMONHON I
Imuruan Bay
GUIMARAS I
Bacolod
DUMARAN I
Canlaon Vol. 8,038 ft. (2,450 m)
San Carlos
Toledo
Danao
LEYTE
Camotes Sea
Surigao Strait
DINAGAT I
Panay Gulf
Cebu City
Binalbagan
Carcar
Maasin
Dinagat Sound
North Latitude
Honda Bay
BOHOL
SIARGAO I
PALAWAN
Puerto Princesa
CAGAYAN ISLANDS
NEGROS
Bohol Strait
Tagbilaran
Sungao
Bais
Philippine Trench 34,578 ft. (10,539 m) below sea level
Quezon
Bayawan
Tanjay
Dumaguete
Lake Mainit
SIQUIJOR I
CAMIGUIN I
Tolong Bay
Siquijor
Cabadbaran
Tandag
Butuan
Mount Mantalingajan 6,739 ft. (2,054 m)
Bohol Sea
TUBBATAHA REEFS
Dapitan
Balingasag
Gingoog
Liangа
Lianga Bay
Dipolog
Prosperidad
Droqueta
Iligan Bay
Cagayan de Oro
Sulu Sea
BUGSUK I
Sindangan
Ozamiz
Iligan
Malaybalay
Agusan
Lake Sultan Alonto
BALABAC I
BANCORAN I
Marawi
Pagadian
MINDANAO
Balabac Strait
SAN MIGUEL ISLANDS
Zamboanga Peninsula
Malabang
Mt. Ragang 9,236 ft. (2,815 m)
Sibuguey Bay
Illana Bay
Tagum
BANGGI I
Cotabato
Davao
Marudu Bay
CAGAYAN SULU ISLANDS
Moro Gulf
Datu Piang
Mati
Kudat
Zamboanga
Mt. Apo 9,692 ft. (2,954 m)
JAMBONGAN I
Basilan
Digos
Lebak
Davao Gulf
Malalag
BASILAN I
unt Kinabalu 431 ft. (4,094 m)
Labuk Bay
PANGUTARAN I
Koronadal
Cape San Agustin
Sandakan
General Santos
JOLO I
MALAYSIA
Sarangani Bay
Tinaca Point
Kinabatangan
TAWITAWI GROUP
SULU ARCHIPELAGO
Celebes Sea
SARANGANI ISLANDS
Lahad Datu
BORNEO
Darvel Bay
SIBUTU I
120° East Longitude
125°
Miles
Kilometers
Bayombong
Mt. Sto. Tomas 7,402 ft. (2,256 m)
Bambang
Cagayan
Dagupan
Tayug
SIERRA MADRE
Urdaneta
Dasol Bay
Baler Bay
Muñoz
San Jose
Cape Encanto
Agno
Paniqui
Rizal
Camiling
Palayan
Guimba
ZAMBALES MTS.
Cabanatuan
Pampanga
Dingalan Bay
Gapan
Mount Pinatubo
San Fernando
San Marcelino
San Antonio
Malolos
Caloocan
Polillo Strait
Subic Bay
Balanga
Bataan Peninsula
CORREGIDOR I
Pasig
Laguna de Bay
Paete
Muntinglupa
Calamba
Santa Cruz
Trece Martires
Tagaytay
Lucban
San Pablo
Lake Taal
LUBANG I
Lemery
Lucena
50 Miles
50 Kilometers
Batangas
Tayabas Bay

use in making rope. Fruit plantations cover vast stretches of land.

Samar, *SAH mahr* (area 5,050 square miles, or 13,080 square kilometers), lies in the Visayas. Farmers on the island grow abacá, coconuts, rice, and corn. Industrial development on Samar has caused serious ecological problems. Many of its forests have been cut back, and copper mining and manufacturing have polluted its rivers and streams.

Negros, *NEH grohs* or *NAY grohs* (area 4,905 square miles, or 12,705 square kilometers), in the Visayas, produces sugar and tobacco. Volcanic lava helps fertilize the soil.

Palawan, *pah LAH wahn* (area 4,550 square miles, or 11,785 square kilometers), lies west of the Visayas. Much of Palawan consists of forested hills, but the forests have been rapidly cut back. The people on Palawan raise corn, rice, and vegetables on hillside farms.

Panay, *pah NY* (area 4,446 square miles, or 11,515 square kilometers), in the Visayas, grows coconuts and sugar cane. The Iloilo Plain, in southeastern Panay, is one of the country's most fertile, thickly populated areas.

Mindoro, *mihn DOHR oh* (area 3,759 square miles, or 9,735 square kilometers), is in the northern group. Mindoro produces coconuts, rice, sugar cane, and Philippine mahogany.

Leyte, *LAY teh* or *LAY tee* (area 2,785 square miles, or



© Ted Welch, Atoz Images

Mayon Volcano, on southern Luzon, forms a perfectly shaped cone. It rises nearly 8,000 feet (2,400 meters) and is active.



© Robert Frerck

Rice fields of central Luzon produce more of this important food crop than any other area of the Philippines.

7,214 square kilometers), in the Visayas, became famou during World War II. It was the scene of the first landi of U.S. troops when they recaptured the Philippines from the Japanese in 1944 and 1945. Farms on Leyte pr duce abacá, rice, and coconuts.

Cebu, *seh BOO* or *say BOO* (area 1,707 square miles or 4,422 square kilometers), in the Visayas, is the most densely populated island. It produces corn, rice, sugar cane, tobacco, and coconuts. Its chief city, Cebu City, i a busy port.

Bohol, *boh HAWL* (area 1,492 square miles, or 3,865 square kilometers), lies in the Visayas. The people on this thickly populated island raise corn, rice, coconuts, and abacá.

Masbate, *mahs BAH teh* or *mahs BAH tuh* (area 1,26 square miles, or 3,269 square kilometers), in the Visay is a chief gold-mining area. Scattered farmlands on the island produce coconuts, rice, corn, and sugar cane.

Climate. The Philippines has a hot, humid climate. During the hottest months, from March to May, tempe atures may reach 100 °F. (38 °C). The weather cools off during the rainy season, which lasts from June to Febr ary, but the temperature seldom falls below 70 °F (21 ° Manila has an average temperature of 75 °F (24 °C) in January and 82 °F (28 °C) in May.

Rainfall in the Philippines averages 100 inches (250 centimeters) a year, with some areas receiving up to 1 inches (457 centimeters). The lowlands have less rain than the uplands because the mountains block winds that carry rain-bearing clouds from the ocean. About f typhoons strike the Philippines yearly, causing proper damage and loss of life.

Economy

In the late 1900's and early 2000's, the Philippine eco omy grew less rapidly than the economies of many ot er Asian countries. Unemployment and underemploy ment have been persistent problems. About 20 perce of households in urban areas and almost 50 percent o households in rural areas live below the poverty line.

About 40 percent of Philippine workers make their ing in agriculture, forestry, or fishing. About 45 perce work in service industries, which include education, government, medicine, trade, transportation, commu cation, and financial services. About 15 percent work i manufacturing, construction, and mining.

Agriculture. Filipinos farm only about 35 percent the nation's land. But they produce most of the food f the entire population. Farmers grow rice and corn on about two-thirds of the cultivated land. Other leading food crops include sweet potatoes and *cassava* (a starchy root). Bananas, coconuts, mangoes, pineapple and sugar cane are raised for local use and for export Farmers also raise abacá, hogs, poultry, and tobacco.

Many of the farmers rent land and pay the owner a share of the crop. Most farms lie on lowlands, but far ers also raise crops on hillsides and mountain slopes.

Forestry. Forests cover about one-third of the land the Philippines. More than 3,000 kinds of trees grow i the islands. About 90 percent of the lumber comes fr several related *dipterocarp* trees called Philippine ma hoganies. Mangroves and pines also yield lumber. Th kapok tree produces a fiber, also called kapok, used i making insulation, mattresses, and upholstery. Bamb

rows throughout the islands. Filipinos use the stiff, holıw stems of this plant in building houses and in making askets, furniture, and other items.

Mining. Minerals from rich deposits make up a large art of the Philippines' exports. Copper, the leading minral, occurs mostly on Luzon, Cebu, Negros, and Samar. ırge gold mines operate in northern Luzon. The couny also has deposits of chromite, coal, iron ore, limeone, manganese, nickel, silver, and zinc.

Fishing industry. Anchovies, mackerel, sardines, :ad, tuna, and other fishes are caught in the waters surounding the Philippines. Crabs and shrimp also live in e island waters. Near the southern islands, divers gath- sponges and certain shellfish, including clams and ysters, from which mother-of-pearl is obtained. Milkšh, shrimp, and tilapia are raised in ponds built along e ocean shores and near the mouths of rivers.



© Bruno Zehnder from Peter Arnold

anila hemp, commonly called *abacá,* is grown in the Philipnes. Its leaves contain a strong fiber used in making rope. This cture shows workers preparing the fiber for market.



© Tom McHugh, Photo Researchers, Inc.

e port of Manila is the busiest Philippine port. The nation dends heavily on ships for transportation and trade.

Manufacturing. The principal industries of the Philippines produce cement, chemicals, cigars, clothing, foods and beverages, refined metals and petroleum, sugar, textiles, and wood products. Many companies operate in *export-processing zones,* where businesses can import foreign goods without paying import taxes. Factories in these areas produce such items as electronic equipment, clothing, shoes, and furniture.

Foreign trade. The Philippines cannot produce everything it needs, and so it depends heavily on foreign trade. The nation's chief imports include chemicals, machinery, and petroleum. It trades mainly with Japan and the United States. Electronic equipment and clothing are the Philippines' most valuable exports. The country also exports bananas, coconut products, copper, gold, lumber, pineapples, and sugar.

Transportation. The Philippines has an extensive network of roads. In most cities, brightly decorated vehicles called *jeepneys* serve as shared taxis. They pick up as many passengers as can be crammed in. Buses and jeepneys provide most local transportation in the islands. The Philippines has an average of about 1 automobile for every 80 people. The nation's railroads operate largely on Luzon. The Manila area has an elevated light rail rapid transit system. The government plans to extend the rail lines to ease traffic jams.

Ships and airplanes carry passengers and cargo from one island to another. Manila is the country's busiest port. Other leading ports include Cebu City and Davao. Manila has a major international airport.

Communication. The Philippines has about 20 daily newspapers. Most are published in English, and some are printed in Filipino, Chinese, or other languages. Among the largest newspapers are *Bulletin Today* and *The Times Journal,* both printed in Manila. Almost two-thirds of urban households and about one-quarter of rural households own a television set. There are several television networks.

History

Early days. A tribe of Negritos called the Aeta were probably the first people who lived in the Philippines. Anthropologists believe they came to the islands from the Southeast Asian mainland more than 30,000 years ago. About 3000 B.C., groups of people who spoke a language related to Malay began to settle along the coasts of the islands. As newcomers arrived, the earlier settlers moved inland and formed small communities. Each group developed its own culture.

Spanish settlement and rule. In 1521, a Spanish expedition led by Ferdinand Magellan arrived in the Philippines. Magellan was killed in a battle with native warriors several weeks afterward, and his fleet later departed for Spain. Another group of Spanish explorers, led by General Miguel López de Legazpi, claimed the islands for Spain. They established a settlement in the Philippines in 1565. The Spaniards ruled the Philippines from Manila under the Viceroy of Mexico. They divided the land among themselves and employed Filipinos as tenant farmers, laborers, and servants. Spanish priests converted most of the Filipinos to Roman Catholicism.

Revolt against the Spaniards. Spain opened the islands to foreign trade during the 1800's, and the Philippine economy grew rapidly. Wealthy Filipinos began

sending their children to universities in Manila and Europe. After these young people returned home, they began to seek political and social freedom from Spain. An early leader in the freedom movement was José Rizal, a physician. Rizal worked for reform until 1896, when the Spaniards executed him for his activities.

In 1892, Andres Bonifacio, an office clerk, formed a secret revolutionary society called the *Katipunan*. This group tried to overthrow the government in 1896, and Bonifacio was killed in the revolt. Emilio Aguinaldo, a local chief of the Katipunan, became the leader of the revolutionary forces. The colonial authorities promised political reforms if Aguinaldo ended the revolt and left the Philippines. Aguinaldo agreed and sailed to Hong Kong.

The Spanish-American War. The United States declared war on Spain in April 1898. On May 1, in the first important battle of the war, the U.S. fleet destroyed all the Spanish ships in Manila Bay. Two weeks later, Aguinaldo returned to the islands and formed an army. His forces helped the Americans fight the Spaniards, who had broken their promises to Aguinaldo. On June 12, Aguinaldo declared the Philippines independent from Spain. Philippine and American soldiers defeated the Spanish troops in August, and the war in the islands ended. The United States and Spain signed a peace treaty in December 1898. Under the treaty, the United States gained possession of the Philippines and paid Spain $20 million for the islands.

Aguinaldo claimed that the United States had promised to make the Philippines independent immediately. He declared the establishment of the Philippine Republic on Jan. 23, 1899, and his troops began fighting the Americans on February 4. The Americans captured Aguinaldo in March 1901, and the fighting ended about a year later.

American rule. In 1901, the United States set up a colonial government in the Philippines. William Howard Taft, a federal judge who later became president of the United States, served as the first civilian governor. During the period of American rule, the use of English spread rapidly throughout the islands. American businesses made large investments in the Philippines, and the economy became dependent on the United States.

During the early 1900's, the United States began to allow Filipinos to hold positions in the government. In 1935, the Philippines became a commonwealth with its own elected government and a Constitution modeled after that of the United States. Manuel Quezon became the first president of the commonwealth government. The United States retained authority in such areas as foreign affairs and national defense of the Philippines.

Japanese control. On Dec. 7, 1941, Japanese planes bombed Pearl Harbor, a U.S. naval base in Hawaii. The United States entered World War II the next day. On December 10, Japanese troops invaded the Philippines. American and Philippine forces, led by General Douglas MacArthur, fought them until 1942. MacArthur then left the islands, and Lieutenant General Jonathan M. Wainwright took command of his troops. Large numbers of these troops surrendered to the Japanese in April, though Wainwright and a smaller group held out until May. Most of the American and Philippine soldiers were imprisoned. But others escaped to the mountains along with peasants under communist leadership and continued to resist the Japanese throughout the war.

MacArthur returned to the Philippines with additional troops in October 1944 and defeated the Japanese several months later. The war hurt the Philippine economy badly and destroyed most of Manila.

Independence. The United States granted the Philippines complete independence on July 4, 1946. The Republic of the Philippines was established, with Manuel Roxas as president and Manila the capital. In 1948, Quezon City became the official capital, but Manila remained the seat of the government.

During the late 1940's, political problems and poverty caused widespread discontent among the Philippine people. A Communist-led group called the *Hukbong Magpapalayang Bayan* (People's Liberation Army) tried to take over the government. Its members, known as *Huks,* demanded that the government divide the estates of the wealthy landowners into small lots and give the land to poor farmers. The Philippine Army began to fight the Huks in 1949 and, with the support of the United States, defeated them in 1954.

The Philippines also faced economic problems after gaining independence. The United States sent economic aid, but the economy showed little growth. In 1950, the United States gave additional economic aid. In return, the Philippine government agreed to allow the United States to maintain an air force base—Clark Air Base—and a naval base—Subic Bay Naval Station—on Luzon. The economy began to improve as industries built new plants. Trade with other countries increased. Also, farmers began to use modern methods of agriculture. However, much of the nation remained in poverty.

The Marcos era. In 1965, Ferdinand E. Marcos became president of the Philippines. As president, Marcos sponsored a foreign investment law that encouraged foreign firms to establish factories in the Philippines. He was reelected president in 1969.

Philippine Communists renewed their antigovernment activities in the late 1960's and early 1970's. Young Filipinos organized the New People's Army, which attacked military installations. Many Muslims demanded independence for areas with predominantly Muslim populations. Muslim uprisings occurred on several southern islands. Marcos declared martial law in 1972.

Important dates in the Philippines

c. 3000 B.C. Malays from Indonesia and Malaysia began settling in the Philippines.

A.D. 1521 Ferdinand Magellan landed in the Philippines.

1565 Spanish explorers claimed the Philippines for Spain and established a permanent settlement.

1896 The Spaniards executed José Rizal, a leader of the Philippine independence movement. Emilio Aguinaldo led a revolt against the Spaniards.

1898 Aguinaldo declared independence from Spain on June 12. In December, Spain signed a treaty passing control of the Philippines to the United States.

1942-1944 Japan controlled the Philippines.

1946 The Philippines gained independence.

1954 The Philippine Army defeated the Communist-led Huk rebels after a five-year fight.

1972 President Ferdinand E. Marcos declared a state of martial law, which lasted until 1981.

1986 Widespread protests against President Marcos forced him to leave office.

restricted political parties, labor unions, and other oups that opposed the government.

In 1973, Marcos announced a new constitution that ve him the powers of both president and prime minis-r for an unlimited term. In 1976, by presidential de-ee, Manila again became the nation's capital. Marcos ded martial law in January 1981. In June, he was re-ected president in an election widely regarded as ged.

In 1983, Benigno S. Aquino, Jr., Marcos's leading polit-l rival, was assassinated upon his return to the Philip-nes from self-exile in the United States. Followers of uino charged that the government played a role in killing. A short time later, a court tried the chief of ff of the armed forces, 24 other military men, and one ilian for Aquino's murder. The court acquitted all the cused men in 1985. The acquittal was overturned in 86, and a new trial was held. In 1990, 16 military men re convicted and sentenced to life in prison.

Unrest due to political restrictions and declining eco-mic conditions forced Marcos to hold a presidential ction in February 1986. Corazon Aquino, widow of nigno Aquino, became Marcos's chief opponent. The tional Assembly ruled that Marcos won the election. rge numbers of Filipinos, including bishops of the Ro-n Catholic Church, accused Marcos's supporters of ction fraud. When leading military officers staged a bellion, thousands of people in nearly every province monstrated against Marcos. The strength of popular position forced Marcos to leave the country. Corazon uino took over as president.

Recovering democracy. In February 1987, the Fil-inos voted to approve a new constitution, which pro-led that Aquino serve as president until 1992.

The Marcos administration left behind serious eco-mic problems. Officials charged that Marcos, who ed in 1989, had stolen millions of dollars. In addition, country owed billions of dollars to foreign banks.

Aquino faced opposition from Marcos supporters, m members of the military who objected to negotia-ns with Communist guerrillas, and from groups who posed U.S. influence in the Philippines. Members of military tried several times to overthrow Aquino's vernment but failed to do so. In 1992, Fidel V. Ramos, o had served as deputy chief of staff of the armed ces under Marcos and as defense minister under uino, was elected president.

n 1991, Mount Pinatubo, a volcano on Luzon, erupt-, killing over 800 people. Clark Air Base was buried der ash and abandoned. The treaty allowing the Unit-States to occupy the air base and Subic Bay Naval tion expired in 1992. Many Filipinos opposed renew- the agreement, and the Philippine Senate voted ainst it. The United States withdrew from Subic Bay val Station.

Muslim rebel groups in the Philippines had been hting for independence since the 1970's. In 1996, the vernment signed a peace agreement with the largest el group, the Moro National Liberation Front. The eement created a region of self-rule for Muslims in southern Philippines. Despite the agreement, fight- continued between the government and two other slim rebel groups, the Moro Islamic Liberation Front d Abu Sayyaf.



Reuters/Bettmann

Automobiles covered with volcanic ash lined streets after Mount Pinatubo erupted. Pinatubo, a volcanic mountain on Luzon, erupted in 1991 for the first time in 600 years.

Recent developments. In 1998, Joseph Estrada was elected president. In 2000, Estrada was accused of corruption. He denied the charges and refused to resign, despite widespread protests. The Philippine House of Representatives voted to *impeach* him—to bring charges of wrongdoing against him, which, if proved, would result in his removal from office. The Senate began the trial, but in 2001, before a verdict was reached, Estrada lost the support of most politicians and the armed forces. Amid continued protests, he was forced to step down and was replaced by his vice president, Gloria Macapagal-Arroyo.

In 2001, the government signed a cease-fire with the Moro Islamic Liberation Front. However, the government refused to negotiate with Abu Sayyaf because it used such tactics as kidnapping. James Putzel

Related articles in *World Book* include:

Biographies

Aguinaldo, Emilio
Aquino, Corazon
MacArthur, Douglas
Marcos, Ferdinand E.
Rizal, José
Romulo, Carlos P.
Roxas y Acuña, Manuel
Taft, William Howard

Other related articles

Asian Americans (History of Asian immigration)
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Baguio City
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Manila Bay
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Sulu Sea
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Zamboanga

Outline

I. Government
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B. Climate

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A. Agriculture
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H. Communication

V. History

Questions

What is the chief religion in the Philippines?
What is a *barangay?* A *balintawak?*
What is the largest and most important island of the Philippines?
Why do the Philippine people have many cultural differences?
What are the leading crops in the Philippines?
What events helped end the presidency of Ferdinand Marcos?
How did the Philippines get its name?
What are *jeepneys?*
When did the Philippines gain independence?
What country colonized the Philippines in the 1500's?

Additional resources

Oleksy, Walter G. *The Philippines.* Children's Pr., 2000. Younger readers.
Parkes, Carl. *Philippines Handbook.* 3rd ed. Moon Pubns., 1999.
Steinberg, David J. *The Philippines.* 4th ed. Westview, 2000.

Philistines, *FIHL uh steenz* or *fuh LIHS tihnz,* were an ancient people who settled along the coast of Canaan about the same time that the Israelites were entering the land from the east. The Philistines were part of a larger movement known as the Sea Peoples who had fled the Aegean area near the end of the 1200's B.C. The center of the Philistine territory was in and around the cities of Gaza, Ashkelon, Ashdod, Ekron, and Gath. This area corresponds to what is now southwestern Israel. The name *Palestine,* used for this region and nearby areas, comes from the name *Philistine.*

During the 1100's and 1000's, the Philistines and the Israelites fought many battles. The Philistines had learned the art of smelting iron from the Hittites. This gave them a military and economic advantage over the Israelites. Only after the Israelites anointed Saul as their first king about 1029 B.C. did they become strong enough to drive the Philistines back. After David became king of Israel about 1000 B.C., he subdued the Philistines. After about 600 B.C., the Philistines ceased to exist as a distinct people. The word *philistine* today means a person who is indifferent or hostile to the arts. H. Darrell Lance

See also **David** (Early life); **Samson.**

Phillips, Wendell (1811-1884), an orator and reformer, became famous as a supporter of abolition. In Boston in 1837, Phillips delivered an address rebuking those who upheld the mob murder of Elijah P. Lovejoy, an antislavery leader, in Alton, Illinois. Phillips's address became one of the most famous speeches in history for its protest against mob rule. His other well-known speeches include "Burial of John Brown," "Toussaint L'Ouverture," and "The Lost Arts."

Unyielding in his opposition to slavery, Phillips gave up his law practice in 1837 to join William Lloyd Garrison's group of abolitionists. He fought courageously against any individual, institution, or law that he thought prevented abolition. Phillips favored ending slavery even at the cost of breaking up the Union. He severely criticized the administration of President Abraham Lincoln during the American Civil War (1861-1865).

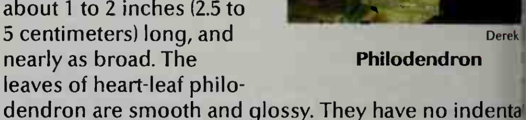
After the war, Phillips held together the American Anti-Slavery Society until the 15th Amendment was passed. This amendment made it illegal to deny the right to vote on the basis of race. Phillips also became interested in improving conditions for laborers. In 1870, the Prohibition and Labor Reform parties nominated him for governor of Massachusetts, and he won almost 15 percent of the vote.

Phillips was born on Nov. 9, 1811, in Boston. He graduated from Harvard University. He died on Feb. 3, 1884 Michael F. Holt

See also **Abolition movement.**

Philodendron, *FIHL uh DEHN druhn,* is the name of many species and varieties of vinelike house plants grown for their attractive foliage. *Philodendron* means *lover of trees.* Many philodendrons are grown on post made of sphagnum moss, bark, and other materials. Th plants produce roots along their stems and will grow poles if the stems are kept moist.

Philodendrons have handsome leaves that are thick and tough. But the leaves vary widely in size and shape on the different species of plants. The common name for some of these plants often suggests the form of their leaves. Among them are the *taper-tip, twice-cut, giant-leaf,* and *tri-leaf* philodendron.



Derek

Philodendron

Perhaps the most widely grown is the *heart-leaf* philodendron. This plant bears heart-shaped leaves about 1 to 2 inches (2.5 to 5 centimeters) long, and nearly as broad. The leaves of heart-leaf philodendron are smooth and glossy. They have no indentations along their edges.

Philodendrons are easy to grow as house plants. Th tolerate the changes in light, moisture, and temperatu that are common in most houses. They need little care and do not fall prey to the usual plant pests. They grow best when they are not in direct sunlight. Often philodendrons will grow well in places that are too dark for other plants. They can be grown in almost any kind of soil and will also thrive in water. Theodore R. Dudley

Scientific classification. Philodendrons belong to the aru family, Araceae. The heart-leaf philodendron is *Philodendron cordatum.*

Philology. See **Linguistics.**

Philosophes, *FIHL uh ZAHFS,* were a group of Frenc philosophers during the Age of Reason, a historical pe riod that extended from the late 1600's to the late 1700 The group included such great philosophers as the Marquis de Condorcet, Denis Diderot, Claude Helvéti Jean-Jacques Rousseau, and Voltaire.

Generally, the philosophes believed in the ideal of progress. They wished to apply science's emphasis on reason to the study of people's moral and social life. T philosophes believed that knowledge could be acquired through experience. They wanted to separate moral doctrines from religious considerations, becaus they believed that moral problems could be solved independently. The philosophes were generally anti-Christian, claiming that Christianity was basically unrea sonable and superstitious. Generally, they opposed th political system in France and argued for reforms. Thu they became forerunners of, and in some cases partic pants in, the French Revolution—which lasted from 17 to 1799 (see **French Revolution**). James Creech

See also **Age of Reason; History** (Antiquarian research and the philosophes).

hilosophy is a study that seeks to understand the ysteries of existence and reality. It tries to discover the ature of truth and knowledge and to find what is of bac value and importance in life. It also examines the retionships between humanity and nature and between e individual and society. Philosophy arises out of wonər, curiosity, and the desire to know and understand. hilosophy is thus a form of inquiry—a process of analys, criticism, interpretation, and speculation.

The term *philosophy* cannot be defined precisely beuse the subject is so complex and so controversial. ifferent philosophers have different views of the nare, methods, and range of philosophy. The term *phisophy* itself comes from the Greek *philosophia,* which eans *love of wisdom.* In that sense, wisdom is the ace use of intelligence, not something passive that a erson simply possesses.

The first known Western philosophers lived in the anent Greek world during the early 500's B.C. These early hilosophers tried to discover the basic makeup of ings and the nature of the world and of reality. For anvers to questions about such subjects, people had rgely relied on magic, superstition, religion, tradition, authority. But the Greek philosophers considered ose sources of knowledge unreliable. Instead, they ought answers by thinking and by studying nature.

Philosophy has also had a long history in some non'estern cultures, especially in China and India. But until bout 200 years ago, there was little interchange beveen those philosophies and Western philosophy, iefly because of difficulties of travel and communican. As a result, Western philosophy generally develed independently of Eastern philosophy.

The importance of philosophy

Philosophic thought is an inescapable part of human istence. Almost everyone has been puzzled from time time by such essentially philosophic questions as /hat does life mean?" "Did I have any existence before I as born?" and "Is there life after death?" Most people so have some kind of philosophy in the sense of a pernal outlook on life. Even a person who claims that nsidering philosophic questions is a waste of time is pressing what is important, worthwhile, or valuable. A jection of all philosophy is in itself philosophy.

By studying philosophy, people can clarify what they lieve, and they can be stimulated to think about ultiate questions. A person can study philosophers of the st to discover why they thought as they did and what lue their thoughts may have in one's own life. There e people who simply enjoy reading the great philosoers, especially those who were also great writers.

Philosophy has had enormous influence on our everyy lives. The very language we speak uses classificans derived from philosophy. For example, the classifitions of noun and verb involve the philosophic idea at there is a difference between things and actions. If e ask what the difference is, we are starting a philophic inquiry.

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Every institution of society is based on philosophic ideas, whether that institution is the law, government, religion, the family, marriage, industry, business, or education. Philosophic differences have led to the overthrow of governments, drastic changes in laws, and the transformation of entire economic systems. Such changes have occurred because the people involved held certain beliefs about what is important, true, real, and significant and about how life should be ordered.

Systems of education follow a society's philosophic ideas about what children should be taught and for what purposes. Democratic societies stress that people learn to think and make choices for themselves. Nondemocratic societies discourage such activities and want their citizens to surrender their own interests to those of the state. The values and skills taught by the educational system of a society thus reflect the society's philosophic ideas of what is important.

The branches of philosophy

Philosophic inquiry can be made into any subject because philosophy deals with everything in the world and all of knowledge. But traditionally, and for purposes of study, philosophy is divided into five branches, each organized around certain distinctive questions. The branches are (1) metaphysics, (2) epistemology, (3) logic, (4) ethics, and (5) aesthetics. In addition, the philosophy of language became so important during the 1900's that it is often considered another branch of philosophy.

Metaphysics is the study of the fundamental nature of reality and existence and of the essences of things. Metaphysics is itself often divided into two areas—*ontology* and *cosmology.* Ontology is the study of being. Cosmology is the study of the physical universe, or the cosmos, taken as a whole. Cosmology is also the name of the branch of science that studies the organization, history, and future of the universe.

Metaphysics deals with such questions as "What is real?" "What is the distinction between appearance and reality?" "What are the most general principles and concepts by which our experiences can be interpreted and understood?" and "Do we possess free will or are our actions determined by causes over which we have no control?"

Philosophers have developed a number of theories in metaphysics. These theories include *materialism, idealism, mechanism,* and *teleology.* Materialism maintains that only matter has real existence and that feelings, thoughts, and other mental phenomena are produced by the activity of matter. Idealism states that every material thing is an idea or a form of an idea. In idealism, mental phenomena are what is fundamentally important and real. Mechanism maintains that all happenings result from purely mechanical forces, not from purpose, and that it makes no sense to speak of the universe itself as having a purpose. Teleology, on the other hand, states that the universe and everything in it exists and occurs for some purpose.

Epistemology aims to determine the nature, basis, and extent of knowledge. It explores the various ways of knowing, the nature of truth, and the relationships between knowledge and belief. Epistemology asks such questions as "What are the features of genuine knowledge as distinct from what appears to be knowledge?"

"What is truth, and how can we know what is true and what is false?" and "Are there different kinds of knowledge, with different grounds and characteristics?"

Philosophers often distinguish between two kinds of knowledge, *a priori* and *empirical.* We arrive at a priori knowledge by thinking, without independent appeal to experience. For example, we know that there are 60 seconds in a minute by learning the meanings of the terms. In the same way, we know that there are 60 minutes in an hour. From these facts, we can deduce that there are 3,600 seconds in an hour, and we arrive at this conclusion by the operation of thought alone. We acquire empirical knowledge from observation and experience. For example, we know from observation how many keys are on a typewriter and from experience which key will print what letter.

The nature of truth has baffled people since ancient times, partly because people so often use the term *true* for ideas they find congenial and want to believe, and also because people so often disagree about which ideas are true. Philosophers have attempted to define criteria for distinguishing between truth and error. But they disagree about what truth means and how to arrive at true ideas. The *correspondence theory* holds that an idea is true if it corresponds to the facts or reality. The *pragmatic theory* maintains that an idea is true if it works or settles the problem it deals with. The *coherence theory* states that truth is a matter of degree and that an idea is true to the extent to which it *coheres* (fits together) with other ideas that one holds. *Skepticism* claims that knowledge is impossible to attain and that truth is unknowable.

Logic is the study of the principles and methods of reasoning. It explores how we distinguish between good (or sound) reasoning and bad (or unsound) reasoning. An instance of reasoning is called an *argument* or an *inference.* An argument consists of a set of statements called *premises* together with a statement called the *conclusion,* which is supposed to be supported by or derived from the premises. A good argument provides support for its conclusion, and a bad argument does not. Two basic types of reasoning are called *deductive* and *inductive.*

A good deductive argument is said to be *valid*—that is, the conclusion necessarily follows from the premise A deductive argument whose conclusion does not follow necessarily from the premises is said to be *invalid.* The argument "All human beings are mortal, all Greeks are human beings, therefore all Greeks are mortal" is a valid deductive argument. But the argument "All humar beings are mortal, all Greeks are mortal, therefore all Greeks are human beings" is invalid, even though the conclusion is true. On that line of reasoning, one could argue that all dogs, which are also mortal, are human beings.

Deductive reasoning is used to explore the necessar consequences of certain assumptions. Inductive reasoi ing is used to establish matters of fact and the laws of nature and does not aim at being deductively valid. On who reasons that all squirrels like nuts, on the basis th all squirrels so far observed like nuts, is reasoning inductively. The conclusion could be false, even though the premise is true. Nevertheless, the premise provide considerable support for the conclusion.

Ethics concerns human conduct, character, and values. It studies the nature of right and wrong and the di tinction between good and evil. Ethics explores the nature of justice and of a just society, and also one's obligations to oneself, to others, and to society.

Ethics asks such questions as "What makes right actions right and wrong actions wrong?" "What is good and what is bad?" and "What are the proper values of life?" Problems arise in ethics because we often have d ficulty knowing exactly what is the right thing to do. In many cases, our obligations conflict or are vague. In ac dition, people often disagree about whether a particul action or principle is morally right or wrong.

A view called *relativism* maintains that what is right wrong depends on the particular culture concerned. What is right in one society may be wrong in another,

Terms used in philosophy

Aesthetics is the branch of philosophy that studies art and beauty.

Cosmology is the study of the physical universe.

Determinism is the doctrine that all events have causes and occur by necessity.

Dialectic in the philosophy of G. W. F. Hegel is a process of change brought about by the conflict of opposites. This conflict creates a new unity, called a *synthesis.* The synthesis, in turn, comes into conflict with its opposite.

Empiricism is the view that experience is the source and test of knowledge.

Epicureanism is the belief that pleasure should be the goal of human activity but that true pleasure depends on self-control, moderation, and honorable behavior.

Epistemology is the branch of philosophy that studies the nature, basis, and extent of knowledge.

Ethics is the branch of philosophy that studies human conduct and the nature of right and wrong.

Hedonism is the belief that the pleasure is the highest good.

Humanism is a philosophy that stresses the importance of human beings and their nature and place in the universe.

Idealism is the belief that fundamental reality is made up of minds and ideas, not of material objects. Idealists believe th the existence of objects depends on minds and ideas.

Logic is the branch of philosophy that deals with the principle of reasoning.

Materialism is a belief that only matter has real existence and that mental phenomena are produced by the activity of matter.

Metaphysics is the branch of philosophy that seeks to understand the nature of being and reality.

Pragmatism is a philosophy that tests the truth and value of ideas by their practical consequences.

Rationalism is the theory that knowledge can be derived fror reason by itself, independent of the senses.

Realism is the doctrine that things exist in and of themselves, independent of ideas that people may have about them.

Skepticism is a philosophy that claims we can never have rea knowledge of anything.

Utilitarianism is the belief that human conduct should be based on what produces the greatest good for the greatest number of people.

s view argues, and so no basic standards exist by ich a culture may be judged right or wrong. *Objectiv-* n claims that there are objective standards of right d wrong which can be discovered and which apply to eryone. *Subjectivism* states that all moral standards subjective matters of taste or opinion.

Aesthetics deals with the creation and principles of and beauty. It also studies our thoughts, feelings, and itudes when we see, hear, or read something beauti-. Something beautiful may be a work of art, such as a inting, symphony, or poem, or it may be a sunset or ier natural phenomenon. In addition, aesthetics inves-ates the experience of engaging in such activities as inting, dancing, acting, and playing.

Aesthetics is sometimes identified with the philoso-y of art, which deals with the nature of art, the proc- of artistic creation, the nature of the aesthetic experi-ce, and the principles of criticism. But aesthetics has der application. It involves both works of art created human beings and the beauty found in nature.

Aesthetics relates to ethics and political philosophy en we ask questions about what role art and beauty ould play in society and in the life of the individual. ch questions include "How can people's taste in the s be improved?" "How should the arts be taught in the iools?" and "Do governments have the right to restrict istic expression?"

The philosophy of language has become especially portant in recent times. Some philosophers claim that philosophic questions arise out of linguistic prob-ns. Others claim that all philosophic questions are re- questions about language. One key question is hat is language?" But there are also questions about relationships between language and thought and ween language and the world, as well as questions out the nature of meaning and of definition.

The question has been raised whether there can be a ically perfect language that would reflect in its cate-ies the essential characteristics of the world. This estion raises questions about the adequacy of ordi-y language as a philosophic tool. All such questions ong to the philosophy of language, which has essen- connections with other branches of philosophy.

Philosophy and other fields

One peculiarity of philosophy is that the question hat is philosophy?" is itself a question of philosophy. the question "What is art?" is not a question of art. question is philosophic. The same is true of such estions as "What is history?" and "What is law?" Each is uestion of philosophy. Such questions are basic to philosophy of education, the philosophy of history, philosophy of law, and other "philosophy of" fields. h of these fields attempts to determine the founda-is, fundamental categories, and methods of a particu- institution or area of study. A strong relationship refore exists between philosophy and other fields of nan activity. This relationship can be seen by examin- two fields: (1) philosophy and science and (2) philos-iy and religion.

Philosophy and science. Science studies natural nomena and the phenomena of society. It does not ly itself. When science does reflect on itself, it be-ies the philosophy of science and examines a number of philosophic questions. These questions include "What is science?" "What is scientific method?" "Does scientific truth provide us with the truth about the universe and reality?" and "What is the value of science?"

Philosophy has given birth to several major fields of scientific study. Until the 1700's, no distinction was made between science and philosophy. For example, physics was called *natural philosophy.* Psychology was part of what was called *moral philosophy.* In the early 1800's, sociology and linguistics separated from philosophy and became distinct areas of study. Logic has always been considered a branch of philosophy. However, logic has now developed to the point where it is also a branch of mathematics, which is a basic science.

Philosophy and science differ in many respects. For example, science has attained definite and tested knowledge of many matters and has thus resolved disagreement about those matters. Philosophy has not. As a result, controversy has always been characteristic of philosophy. Science and philosophy do share one significant goal. Both seek to discover the truth—to answer questions, solve problems, and satisfy curiosity. In the process, both science and philosophy provoke further questions and problems, with each solution bringing more questions and problems.

Philosophy and religion. Historically, philosophy originated in religious questions. These questions concerned the nature and purpose of life and death and the relationship of humanity to superhuman powers or a divine creator. Every society has some form of religion. Most people acquire their religion from their society as they acquire their language. Philosophy inquires into the essence of things, and inquiry into the essence of religion is a philosophic inquiry.

Religious ideas generated some of the earliest philosophic speculations about the nature of life and the universe. The speculations often centered on the idea of a supernatural or superpowerful being who created the universe and who governs it according to unchangeable laws and gives it purpose. Western philosophic tradition has paid much attention to the possibility of demonstrating the existence of God.

The chief goal of some philosophers is not understanding and knowledge. Instead, they try to help people endure the pain, anxiety, and suffering of earthly existence. Such philosophers attempt to make philosophic reflection on the nature and purpose of life perform the function of religion.

Oriental philosophy

There are two main traditions in Oriental philosophy, Chinese and Indian. Both philosophies are basically religious and ethical in origin and character. They are removed from any interest in science.

Traditionally, Chinese philosophy has been largely practical, humanistic, and social in its aims. It developed as a means of bringing about improvements in society and politics. Traditionally, philosophy in India has been chiefly mystical rather than political. It has been dominated by reliance on certain sacred texts, called Vedas, which are considered inspired and true and therefore subject only for commentary and not for criticism. Much of Indian philosophy has emphasized withdrawal from everyday life into the life of the spirit. Chinese philoso-

phy typically called for efforts to participate in the life of the state in order to improve worldly conditions.

Chinese philosophy as we know it started in the 500's B.C. with the philosopher Confucius. His philosophy, called Confucianism, was the official philosophy of China for centuries, though it was reinterpreted by different generations. Confucianism aimed to help people live better and more rewarding lives by discipline and by instruction in the proper goals of life. Candidates for government positions had to pass examinations on Confucian thought, and Confucianism formed the basis for government decisions. No other civilization has placed such emphasis on philosophy.

Other philosophic traditions in China were Taoism, Mohism, and realism. Beginning in the 1100's, a movement known as Neo-Confucianism incorporated elements of all these doctrines.

We do not know exactly when Indian philosophy began. In India, philosophic thought was intermingled with religion, and most Indian philosophic thought has been religious in character and aim. Philosophic commentaries on sacred texts emerge during the 500's B.C. The Indian word for these studies is *darshana,* which means *vision* or *seeing.* It corresponds to what the ancient Greeks called *philosophia.*

In India, as in China, people conceived of philosophy as a way of life, not as a mere intellectual activity. The main aim of Indian philosophy was freedom from the suffering and tension caused by the body and the senses and by attachment to worldly things. The main philosophies developed in India were Hinduism and Buddhism, which were also religions. Yet some Indian philosophers did develop a complex system of logic and carried on investigations in epistemology. Some Indian philosophic ideas have been influential in the West. One such idea is *reincarnation,* the belief that the human soul is successively reborn in new bodies.

The history of Western philosophy

The history of Western philosophy is commonly divided into three periods—ancient, medieval, and modern. The period of ancient philosophy extended from about 600 B.C. to about the A.D. 400's. Medieval philosophy lasted from the 400's to the 1600's. Modern philosophy covers the period from the 1600's to the present.

Ancient philosophy was almost entirely Greek. The greatest philosophers of the ancient world were three Greeks of the 400's and 300's B.C.—Socrates, Plato, and Aristotle. Their philosophy influenced all later Western culture. Our ideas in the fields of metaphysics, science, logic, and ethics originated from their thought. A number of distinctive schools of philosophy also flourished in ancient Greece.

The pre-Socratics were the first Greek philosophers. Their name comes from the fact that most of them lived before the birth of Socrates, which was about 469 B.C. The pre-Socratic philosophers were mainly interested in the nature and source of the universe and the nature of reality. They wanted to identify the fundamental substance that they thought underlay all phenomena, and in terms of which all phenomena could be explained.

Unlike most other people of their time, the pre-Socratic philosophers did not believe that gods or supernatural forces caused natural events. Instead, they sought a natural explanation for natural phenomena. T philosophers saw the universe as a set of connected a unified phenomena for which thought could find an e planation. They gave many different and conflicting an swers to basic philosophic questions. However, the im portance of the pre-Socratics lies not in the truth of th answers but in the fact that they examined the questio in the first place. They had no philosophic tradition to work from, but their ideas provided a tradition for all later philosophers.

Socrates left no writings, though he was constantly engaged in philosophic discussion. Our knowledge o his ideas and methods comes mainly from dialogues written by his pupil Plato. In most of the dialogues, Sc rates appears as the main character, who leads and de velops the process of inquiry.

Socrates lived in Athens and taught in the streets, market place, and gymnasiums. He taught by a questio and-answer method. Socrates tried to get a definition precise view of some abstract idea, such as knowledg virtue, justice, or wisdom. He would use close, sharp questioning, constantly asking "What do you mean?" a "How do you know?" This procedure, called the *Socra method,* became the model for philosophic methods that emphasize debate and discussion.

Socrates wanted to replace vague opinions with cle ideas. He often questioned important Athenians and e posed their empty claims to knowledge and wisdom. This practice made him many enemies, and he was pu to death as a danger to the state. He thus became a sy bol of the philosopher who pursued an argument whe ever it led to arrive at the truth, no matter what the co

Plato believed that we cannot gain knowledge of things through our senses because the objects of sen perception are fleeting and constantly changing. Plato stated that we can have genuine knowledge only of changeless things, such as truth, beauty, and goodnes which are known by the mind. He called such things *ideas* or *forms.*

Plato taught that only ideas are real and that all othe things only reflect ideas. This view became known as *idealism.* According to Plato, the most important idea the idea of good. Knowledge of good is the object of inquiry, a goal to which all other things are subordina Plato stated that the best life is one of contemplation o eternal truths. However, he believed people who have attained this state must return to the world of everyda life and use their skills and knowledge to serve huma ity. Plato also believed that the soul is immortal and th only the body perishes at death. His ideas contributed views about the body, soul, and eternal things later de veloped in Christian theology.

Aristotle, Plato's greatest pupil, wrote about almost every known subject of his day. He invented the idea o a science and of separate sciences, each having distin principles and dealing with different subject matter. H wrote on such topics as physics, astronomy, psychology, biology, physiology, and anatomy. Aristotle also i vestigated what he called "first philosophy," later know as *metaphysics.*

Aristotle created the earliest philosophic system. In his philosophy, all branches of inquiry and knowledge are parts of some overall system and connected by th same concepts and principles. Aristotle believed that

ngs in nature have some purpose. According to his ilosophy, the nature of each thing is determined by its rpose, and all things seek to fulfill their natures by rrying out these purposes.

Aristotle's basic method of inquiry consisted of start- g from what we know or think we know and then ask- g how, what, and why. In his metaphysics, he devel- ed the idea of a *first cause,* which was not itself used by anything, as the ultimate explanation of exist- ce. Christian theologians later adopted this idea as a sic argument for the existence of God. Aristotle taught at everyone aims at some good. He said that happi- ss does not lie in pleasure but in virtuous activity. By tuous activity, he meant behaving according to a *ean* between extremes. For example, courage is the ean between the extremes of cowardice and foolhar- ness. The highest happiness of all, Aristotle believed, as the contemplative use of the mind.

Stoic philosophy and Epicureanism were the two ain schools of Greek philosophy that emerged after e death of Aristotle in 322 B.C. Both schools taught that e purpose of knowing is to enable a person to lead e best and most contented life.

Stoic philosophy was founded by Zeno of Citium. He ught that people should spend their lives trying to cul- ate virtue, the greatest good. The Stoics believed in ict *determinism*—the idea that all things are fated to . Therefore, they said, a wise and virtuous person ac- pts and makes the best of what cannot be changed. oicism spread to Rome. There, the chief Stoics in- uded the statesman Marcus Tullius Cicero, the em- ror Marcus Aurelius, and the teacher Epictetus.

Epicureanism was founded by Epicurus. Epicurus sed his philosophy on *hedonism*—the idea that the ly good in life is pleasure. However, Epicurus taught at not all pleasures are good. The only good pleasures e calm and moderate ones because extreme pleasures uld lead to pain. The highest pleasures, Epicurus said, e physical health and peace of mind, two kinds of free- m from pain.

Skepticism was a school of philosophy founded by rrho of Elis about the same time that Stoic philosophy d Epicureanism flourished. Pyrrho taught that we can ow nothing. Our senses, he said, deceive us and pro- de no accurate knowledge of the way things are. Thus, claims to knowledge are false. Because we can know thing, in this view, we should treat all things with in- fference and make no judgments.

Neoplatonism was a revived version of some of ato's ideas as adapted by Plotinus, a philosopher who ay have been born in Egypt in the A.D. 200's. Neoplato- sm tried to guide the individual toward a unity—a eness—with God, which is a state of blessedness. Plo- us believed that the human soul yearns for reunion th God, which it can achieve only in mystical experi- ce. Neoplatonism provided the bridge between Greek ilosophy and early Christian philosophy. It inspired e idea that important truths can be learned only rough faith and God's influence, not by reason.

Medieval philosophy. During the Middle Ages, estern philosophy developed more as a part of Chris- n theology than as an independent branch of inquiry. e philosophy of Greece and Rome survived only in its fluence on religious thought.

Saint Augustine was the greatest philosopher of the early Middle Ages. In a book titled *The City of God* (early 400's), Augustine interpreted human history as a conflict between faithful Christians living in the city of God and pagans and heretics living in the city of the world. Augustine wrote that the people of the city of God will gain eternal salvation, but the people in the city of the world will receive eternal punishment. The book weakened the belief in the pagan religion of Rome and helped further the spread of Christianity.

A system of thought called *scholasticism* dominated medieval philosophy from about the 1100's to the 1400's. The term *scholasticism* refers to the method of philosophic investigation used by teachers of philosophy and theology in the newly developing universities of western Europe. The teachers were called *scholastics.* The scholastic method consisted in precise analysis of concepts with subtle distinctions between different senses of these concepts. The scholastics used deductive reasoning from principles established by their method to provide solutions to problems.

Scholasticism was basically generated by the translation of Aristotle's works into Latin, the language of the medieval Christian church. These works presented medieval thinkers with the problem of reconciling Aristotle's great body of philosophic thought with the Bible and Christian doctrine. The most famous scholastic was Saint Thomas Aquinas. His philosophy combined Aristotle's thought with theology, and it eventually became the official philosophy of the Roman Catholic Church.

The great contributions of the scholastics to philosophy included major development of the philosophy of language. The scholastics studied how features of language can affect our understanding of the world. They also emphasized the importance of logic to philosophic inquiry.

Modern philosophy. A great cultural movement in Europe called the Renaissance overlapped the end of the Middle Ages and formed a transition between medieval and modern philosophy. The Renaissance began in Italy and lasted from about 1300 to about 1600. It was a time of intellectual reawakening stemming from the rediscovery of ancient Greek and Roman culture. During the Renaissance, major advances occurred in such sciences as astronomy, physics, and mathematics. Scholars called *humanists* stressed the importance of human beings and the study of classical literature as a guide to understanding life. Emphasis on science and on humanism led to changes in the aims and techniques of philosophic inquiry. Scholasticism declined, and philosophy was freed of its ties to medieval theology.

One of the earliest philosophers to support the scientific method was Francis Bacon of England. Most historians consider Bacon and René Descartes of France to be the founders of modern philosophy. Bacon wrote two influential works, *The Advancement of Learning* (1605) and *Novum Organum* (1620). He stated that knowledge was power and that knowledge could be obtained only by the inductive method of investigation. Bacon imagined a new world of culture and leisure that could be gained by inquiry into the laws and processes of nature. In describing this world, he anticipated the effects of advances in science, engineering, and technology.

Rationalism was a philosophic outlook that arose in



St. Augustine of Hippo (1590) oil on canvas by El Greco (The Art Archive)

Saint Augustine was the most important philosopher of the early Middle Ages. In the A.D. 400's, he developed theories on sin, grace, and salvation that greatly influenced Christian doctrine.

the 1600's. The basis of rationalism is that reason is su
rior to experience as a source of knowledge and that
validity of sense perception must be proved from mo
certain principles. The rationalists tried to determine t
nature of the world and of reality by deduction from premises themselves established as certain *a priori.* They also stressed the importance of mathematical pr
cedures. The leading rationalists were René Descartes
Baruch Spinoza, and Gottfried Wilhelm Leibniz.

Descartes was a mathematician as well as a philoso
pher. He invented analytic geometry. Descartes's basic idea was to establish a secure foundation for the sciences, a foundation of the sort he had found for math
matics. He was thus much concerned with the foundations of knowledge, and he started philosophy on its persistent consideration of epistemological problems. Descartes was a *mechanist*—that is, he regarded all physical phenomena as connected mechanically by la
of cause and effect. Descartes's philosophy generated the problem of how mind and matter are related.

Spinoza constructed a system of philosophy on the model of geometry. He attempted to derive philosoph
conclusions from a few central *axioms* (supposedly se
evident truths) and definitions. Spinoza did not view G
as some superhuman being who created the universe
He identified God with the universe. Spinoza was also
mechanist, regarding everything in the universe as determined. Spinoza's main aim was ethical. He wanted t
show how people could be free, could lead reasonabl
and thus satisfying lives, in a deterministic world.

Leibniz believed that the actual world is only one of many possible worlds. He tried to show how the actua
world is the best of all possible worlds in an effort to justify the ways of God to humanity. Thus, he attempte
to solve the problem of how a perfect and all-powerfu
God could have created a world filled with so much su
fering and evil. Leibniz and Sir Isaac Newton, an Englis
scientist, independently developed calculus. Leibniz's work in mathematics anticipated the development of *symbolic logic*—the use of mathematical symbols and
operations to solve problems in logic.

Empiricism emphasizes the importance of experien
and sense perception as the source and basis of know
edge. The first great empiricist was John Locke of England in the 1600's. George Berkeley of Ireland and Davi
Hume of Scotland further developed empiricism in th
1700's.

Locke tried to determine the origin, extent, and certainty of human knowledge in *An Essay Concerning Hu
man Understanding* (1690). Locke argued that there are no *innate* ideas—that is, ideas people are born with. He believed that when a person is born, the mind is like a blank piece of paper. Experience is therefore the sourc
of all ideas and all knowledge.

Berkeley dealt with the question "If whatever a huma
being knows is only an idea, how can one be sure that there is anything in the world corresponding to that idea?" Berkeley answered that "to be is to be perceived
No object exists, he said, unless it is perceived by som
mind. Material objects are ideas in the mind and have no independent existence.

Hume extended the theories of Locke and Berkeley
a consistent skepticism about almost everything. He maintained that everything in the mind consists of im-



Detail of René Descartes Conducts a Demonstration Before Queen Christina of Sweden (about 1700) oil on canvas by Dumesnil (The Art Archive)

René Descartes was one of the founders of modern philosophy. In this painting, Descartes conducts a scientific experiment for Queen Christina of Sweden shortly before his death in 1650.

ressions and ideas, with ideas coming from impressions. Every idea can be traced to and tested by some arlier impression. According to Hume, we must be ble to determine from what impression we derived an ea for that idea to have meaning. An apparent idea that annot be traced to an impression must be meaningless. ume also raised the question of how can we know that e future will be like the past—that the laws of nature ill continue to operate as they have. He claimed that e can only know that events have followed certain patrns in the past. We cannot therefore be certain that ents will continue to follow those patterns.

The Age of Reason was a period of great intellectual tivity that began in the 1600's and lasted until the late 700's. The period is also called the Enlightenment. hilosophers of the Age of Reason stressed the use of ason, as opposed to the reliance on authority and riptural revelation. For them, reason provided means attaining the truth about the world and of ordering uman society to assure human well-being. The leading hilosophers included Descartes, Locke, Berkeley, and ume. They also included Jean-Jacques Rousseau, oltaire, Denis Diderot, and other members of a group French philosophers called the *philosophes.*

Locke's philosophic ideas were characteristic of the ge of Reason. Locke sought to determine the limits of uman understanding and to discover what can be nown within those limits that will serve as a guide to e and conduct. He tried to show that people should e by the principles of toleration, liberty, and natural ghts. His *Two Treatises of Government* (1690) provided e philosophic base for the Revolutionary War in merica and the French Revolution in the late 1700's.

The philosophy of Immanuel Kant, a great German hilosopher of the late 1700's, became the foundation r nearly all later developments in philosophy. Kant's philosophy is called *critical philosophy* or *transcendental philosophy.* Kant was stimulated by the skeptical philosophy of Hume to try to bring about a synthesis of rationalism and empiricism. In his *Critique of Pure Reason* (1781), Kant tried to provide a critical account of the powers and limits of human reason, to determine what is knowable and what is unknowable. Kant concluded that reason can provide knowledge only of things as they appear to us, never of things as they are in themselves. Kant believed that the mind plays an active role in knowing and is not a mere recorder of facts presented by the senses. The mind does this through basic categories or forms of understanding, which are independent of experience and without which our experience would not make sense. Through such categories and the operations of the mind, working on sense experience, we can have knowledge, but only of things that can be experienced.

Kant criticized the traditional arguments for the existence of God. He argued that they are all in error because they make claims that go beyond the possibility of experience and thus go beyond the powers of human reason. In his *Critique of Practical Reason* (1788), Kant argued that *practical reason* (reason applied to practice) can show us how we ought to act and also provides a practical reason for believing in God, though not a proof that God exists.

Philosophy in the 1800's. Kant's philosophy stimulated various systems of thought in the 1800's, such as those of G. W. F. Hegel and Karl Marx of Germany. Hegel developed a theory of historical change called *dialectic,* in which the conflict of opposites results in the creation of a new unity and then its opposite. Hegel's theory was transformed by Marx into *dialectical materialism.* Marx believed that only material things are real. He stated that all ideas are built on an economic base. He believed that



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Jean-Paul Sartre, *behind the microphone,* was an important French philosopher. He led a philosophical movement called Existentialism, which gained world attention in the mid-1900's.

the dialectic of conflict between capitalists and industrial workers will lead to the establishment of communism, which he called *socialism,* as an economic and political system.

Friedrich Nietzsche, a German philosopher, was an atheist who proclaimed in *Thus Spake Zarathustra* (1883-1885) that "God is dead." Nietzsche meant that the idea of God had lost the power to motivate and discipline large masses of people. He believed that people would have to look to some other idea to guide their lives. Nietzsche predicted the evolution of the *superman,* who would be beyond the weakness of human beings and beyond the merely human appeals to morality. He regarded such appeals as appeals to weakness, not strength. He felt that all behavior is based on the *will to power*—the desire of people to control others and their own passions. The superman would develop a new kind of perfection and excellence through the capacity to realize the will to power through strength, rather than weakness.

The dominant philosophy in England during the 1800's was *utilitarianism,* developed by Jeremy Bentham and John Stuart Mill. The utilitarians maintained that the greatest happiness for the greatest number of people is the test of right and wrong. They argued that all existing social institutions, especially law and government, must be transformed to satisfy the test of greatest happiness. In *The Subjection of Women* (1869), Mill wrote that the legal subordination of women to men ought to be replaced by "a principle of perfect equality." That idea was revolutionary in Mill's time.

Philosophy in the 1900's saw five main movements predominate. Two of these movements, *existentialism* and *phenomenology,* had their greatest influence in the countries on the mainland of western Europe. The three other movements, *pragmatism, logical positivism,* and *philosophical analysis,* were influential chiefly in the United States and the United Kingdom.

Existentialism became influential in the mid-1900's. World War II (1939-1945) gave rise to widespread feelings of despair and of separation from the established order. These feelings led to the idea that people have t create their own values in a world in which traditional values no longer govern. Existentialism insists that choi es have to be made arbitrarily by individuals, who thus create themselves, because there are no objective standards to determine choice. The most famous of the existentialist philosophers is the French author Jean-Pa Sartre.

Phenomenology was developed by the German philosopher Edmund Husserl. Husserl conceived the task of phenomenology, hence the task of philosophy, as describing phenomena—the objects of experience—accurately and independently of all assumptions derive from science. He thought that this activity would provid philosophic knowledge of reality.

Pragmatism, represented in the 1900's by William James and John Dewey of the United States, maintains knowledge is subordinate to action. The meaning and truth of ideas are determined by their relation to practice.

Logical positivism, developed in Vienna, Austria, in the 1920's, believes philosophy should analyze the logic of the language of science. It regards science as the onl source of knowledge and claims metaphysics is meaningless. It bases this claim on the principle of *verifiability,* by which a statement is meaningful only if it can be verified by sense experience.

Philosophical analysis generally tries to solve philosophic problems through analysis of language or concepts. Some versions of this philosophy attempt to sho that traditional philosophic problems *dissolve*—that is, disappear—on proper analysis of the terms in which they are expressed. Other versions use linguistic analysis to throw light on, not dissolve, traditional philosoph ic problems. The most influential philosophers practicing philosophic analysis have been Bertrand Russell of England and Ludwig Wittgenstein, who was born in Austria but studied and taught in England.

Marcus G. Singer

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Phlebitis, *flih BY tihs,* is an inflammation of a vein. Phlebitis can develop in any part of the body, but it most commonly occurs in the legs. The condition usually produces tenderness, swelling, redness, and pain in the area of the vein. It may lead to *thrombophlebitis*—that is, the formation of a blood clot along the lining of the inflamed vein. Serious problems can result if the blood clot breaks loose and travels through the bloodstream. The clot may become stuck and create an *embolism* (blockage of a blood vessel). An embolism that occurs in the heart or lungs can be fatal (see **Embolism**).

Most cases of phlebitis are caused by an injury or by an infection of a vein. Phlebitis also may result from poor circulation in the veins due to prolonged bed rest, pregnancy, extreme fatness, or heart failure.

In treating phlebitis of the legs, physicians advise elevation of the affected limb to reduce inflammation. The patient should wear an elastic support stocking when walking. In severe cases of phlebitis, bed rest is required to prevent clots from breaking loose. Drugs called *anticoagulants* may be prescribed to thin the patient's blood and prevent clotting. In some cases, surgery may be necessary. Wilbert S. Aronow

Phlox, *flahks,* is the name of a group of garden plants with brilliantly colored blossoms. One common species, the *annual phlox* or *Drummond phlox,* is native to Texas. Its flowers range in color from white to red or purple and grow in clusters at the top of the stem. The leaves may be long and narrow or egg-shaped. The plant measures 6 to 18 inches (15 to 46 centimeters) high. The *wild sweet William* is a phlox native to the eastern United States. It has white or pink to purple flowers and may grow 5 feet (1.5 meters) high. The *blue phlox* grows in forests from Quebec to Alabama. It may grow 18 inches high and has bluish or pale lilac flowers. James S. Miller

Scientific classification. Phlox plants belong to the phlox family, Polemoniaceae. The annual phlox is *Phlox drummondii.*

See also **Flower** (picture: Garden perennials).

Phnom Penh, *nawm pehn,* is the capital of Cambodia. It lies in the south-central part of the country, where the Tonle Sap and Bassac rivers join the Mekong River. For location, see **Cambodia** (map). Phnom Penh serves as Cambodia's trading and industrial center. The city's products include cigarettes, rubber, and textiles.

Phnom Penh was founded in the 1400's and became the permanent capital in 1867. In 1970, the Vietnam War between Communists and non-Communists spread to Cambodia. A Cambodian Communist group called the Khmer Rouge gained control of the country in 1975. At that time, Phnom Penh had about 2 million people. The Khmer Rouge forced most of the people out of the city

to work in rural areas. The population fell to an estimated 20,000 people. In 1979, Vietnamese troops and a Cambodian Communist group overthrew the Khmer Rouge and took control of Phnom Penh. People then began returning to the city, and the population grew to an estimated 800,000 by the early 1990's.

Charles Keyes and Jane Keyes

Phobia, *FOH bee uh,* is a persistent, strong fear of a certain object or situation. Common phobias include fear of crowds, darkness, heights, and such animals as cats, snakes, or spiders. Phobic individuals may spend much time worrying about their fears and may be too frightened to carry out normal activities. Psychologists and psychiatrists classify phobias as an *anxiety disorder,* a mild psychological problem.

Many phobias have special names. The fear of heights is called *acrophobia. Agoraphobia* is the dread of open spaces, and *claustrophobia* is the fear of small places or of being closed in. *Ailurophobia* is the fear of cats, *ophidiophobia* the fear of snakes, and *arachnophobia* the fear of spiders. Other phobias include *hydrophobia* (fear of water), *mysophobia* (fear of dirt or germs), and *xenophobia* (fear of foreigners or strangers).

Therapists use numerous approaches to treat phobias. Two popular treatments are *psychoanalysis* and *behavioral therapy,* which are based on different ideas about the causes of psychological problems.

Sigmund Freud, an Austrian physician and the founder of psychoanalysis, believed that phobias and other psychological disorders are caused by unconscious desires. According to Freud, individuals *repress* (force into the unconscious mind) desires that they have been taught are bad. Freudians believe that a phobia is a symbolic expression of these repressed feelings, such as aggressive impulses or sexual drives, and of the punishment linked with the feelings in the unconscious. In psychoanalytic treatment of phobias, the therapist and patient try to uncover such repressed feelings. Psychoanalysts believe that when a patient fully understands the repressed feelings, the fear will disappear or become manageable.

Behavioral therapy holds that a phobia is a learned response and can be unlearned. Therapists using behavioral treatments often employ techniques that involve gradually exposing the phobic individual to whatever is feared. The exposure may take place in real life or in the person's imagination. For example, claustrophobic patients may imagine themselves in smaller and smaller rooms until they can visualize a tiny space without anxiety. The gradualness of the exposure is considered important in making the treatment effective and relatively painless. A popular technique called *systematic desensitization* combines gradual exposure with relaxation or other experiences to reduce anxiety.

Many therapists who treat phobias conduct group therapy in addition to individual treatment. Group therapy enables phobic patients to talk with others who have the same fears and learn from one another. Some therapists also use hypnosis to help phobic patients face their fears. E. B. Fisher, Jr.

Phoebe, *FEE bee,* is the name of several species of small birds. The name comes from the male phoebe's call, which sounds like "fee-bee." The *eastern phoebe* is common throughout eastern North America in summer.



WORLD BOOK illustration by Trevor Boyer, Bernard Thornton Ar

The eastern phoebe has brownish-gray feathers.

It has a brownish-gray back and a mostly white breast. measures $6\frac{1}{2}$ to 7 inches (16 to 18 centimeters) in lengt The eastern phoebe nests on rafters and beams, in roc hollows, or under bridges. It builds a nest of weeds, grasses, and mud, and covers it with mosses. The bird usually lays three to six white eggs with pale brown spots. It eats insects that it catches in flight.

Fred J. Alsop III

Scientific classification. Phoebes are in the tyrant flycatche family, Tyrannidae. The scientific name for the eastern phoebe *Sayornis phoebe.*

Phoenicia, *fih NIHSH uh* or *fih NEE shuh,* was the name the ancient Greeks gave to the region which is now roughly the coastal areas of Syria, Lebanon, and Is rael. The Eleutherus River formed the northern boundary and Mount Carmel the southern. This region lay be tween the Lebanon Mountains to the east and the Mediterranean Sea on the west.

The word *Phoenicia* may have developed from the word *Canaan,* meaning *land of purple,* the name first used for ancient Palestine and Syria. Canaan was a mai source of red-purple dyed goods. The Greeks probabl used their word *phoinix,* which meant *red-purple,* whe referring to the people who traded these red-purple goods to them. *Phoínike,* or *Phoenicia,* eventually became the name of Canaan's coastal strip.

The Phoenicians were one of the great peoples of th ancient world. They were great sailors, navigators, and traders. The Phoenicians were among the first to send out explorers and colonists throughout the Mediterranean Sea area, and even beyond the Strait of Gibralta The Greek alphabet developed from that of the Phoeni-



WORLD BOOK m

Location of Phoenicia and its colonies

ians, and the Roman and all Western alphabets have een taken from the Greek.

Way of life

Phoenicians cannot be easily distinguished from other ieoples who lived in Canaan before the Israelites set- ed there. For this reason, the Phoenicians are some- mes called *Canaanites* in the Old Testament. More of- en, they are called *Sidonians,* from the name of the 'hoenician city of Sidon. Scholars now know that the orthern Phoenician city of Ugarit (now Ras Shamra in vestern Syria) was in contact with Cretan civilization as arly as 1900 B.C. Between 1400 and 1200 B.C., a Myce- iaean colony thrived at Ugarit.

Language. The Phoenicians spoke a dialect of the Se- nitic languages. The Phoenician language was closely elated to Hebrew. It was more distantly related to Ara- naic and to the Semitic languages of Mesopotamia, uch as Assyrian and Babylonian. Scholars once be- ieved that the Phoenicians had invented their alphabet ndependently. But later discoveries indicated that they iad adapted it from earlier writing. The Phoenician al- ıhabet consisted of 22 consonant signs. The Greeks ıdded the vowel signs later.

By the beginning of the Christian Era, Aramaic had be- :ome the language of Phoenicia. But North Africans iear the former Phoenician colony of Carthage contin- ıed to speak the Phoenician language until the A.D. i00's, using a dialect called *Punic.* Some names of places n southern Spain, colonized by the Phoenicians in the '00's B.C. or earlier, come from the Phoenician language. The name of *Gades* (now Cádiz, Spain) comes from the Phoenician word for *wall.* The word *bible* comes from the Greek word for *book.* The Greeks took this word from the Phoenician city of Byblos, a trading center for papyrus.

A few fragments of Phoenician literature have survived in Greek translation. Since 1929, important discoveries have been made at the site of ancient Ugarit. Religious inscriptions on clay tablets found there clarify some formerly obscure passages in the Old Testament. The tablets were written in cuneiform, in an alphabetical style that differs from the standard Phoenician.

Trade and manufacturing. The Phoenicians were seagoing traders from the very beginning of their recorded history. The Egyptians knew about the "ships of Gebal" (Byblos) as early as 2900 B.C. But Phoenicia did not reach its peak as a great sea power until about 1000 B.C., and after.

The city of Sidon grew famous for its purple dye, and developed a well-known glass industry. Tyre also had a purple-dyeing industry, and became noted for the bad odor which the dye works caused. Phoenicia was one of the garden spots of the Roman Empire, and exported wine, oil, and laurel and cedar wood, as well as textiles and other manufactured goods.

The Phoenicians learned most of their methods of manufacturing from the Egyptians. They cast, hammered, and engraved metals, such as gold and silver. They carved many objects from ivory, including pieces of furniture. From early times, Phoenicians knew how to weave woolen and linen cloth. The craftworkers dyed

Aleppo Museum, Syria (The Art Archive)

Phoenician art was known for its ivory carvings. This carving shows the birth of the sun god Horus in a lotus blossom protected by the gods. The episode comes from Egyptian mythology. The work dates from 850 to 800 B.C.

the cloth and often sewed it into robes before they sold it. The Greeks later adopted the *keton,* a Phoenician shirtlike garment.

Religion. Phoenicians had many gods and goddesses called *baal* (lord) and *baalat* (lady). All Phoenicians worshiped the same major gods, although these gods sometimes were known by different names in different cities. For example, Melqart, god of Tyre, could also be thought of as the *Baal* of Tyre. The Phoenicians practiced sacrifices similar to those practiced by most other Semitic peoples. But they also offered human sacrifices in Phoenicia and in their colonies, which gained for them a reputation for cruelty.

The story of Astarte and her lover Adonis, well-known in Phoenicia, was carried from there to Greece, where Astarte became the Greek goddess Aphrodite. The Romans later knew her as Venus. The tragic death of her lover by the tusks of a wild boar and her lament for him comes down to us through Greek, Latin, and English literature in the story of Venus and Adonis.

Government. The ancient Phoenicians lived in a number of independent city-states. Like the Greeks, they never united their cities into a single country. These cities originally were aristocracies ruled by kings. Beginning in the 800's B.C., councils of elders ruled with the kings, and some of the councils were more powerful than the kings. Later, most cities were ruled by government officials called *shofets.* Most of the Phoenician mountains came down to the sea, and the ancient towns were originally built on islands, like Tyre and Arvad, or occupied a small harbor area on the mainland with hills in back of it. The most important of these coastal cities were Acco, Arvad, Berytus (now Beirut), Byblos, Sidon, and Tyre. Beirut, the present-day capital and chief seaport of Lebanon, is the only city still important.

History

Foreign control. Phoenicia was a natural meeting place for foreign cultures, because it lay on the main avenue of traffic between Egypt to the south and Asia Minor and Mesopotamia to the east. Egypt exerted the earliest influence on the Phoenicians. As early as the time of the Old Kingdom, from 2686 to 2181 B.C., Egypt was importing the famed cedars of Lebanon. By the time of the Middle Kingdom, from 2052 to 1786 B.C., the two countries had established regular trade. The Phoenicians exported timber and pitch, and imported gold and manufactured articles. In the 1400's B.C., Phoenicia became a frontier province of Egypt, and remained one for about 100 years. During this period, the Phoenician cities influenced Egypt almost as much as Egypt influenced them. Phoenician nobles often visited the Egyptian court. Phoenician cults and religious ideas affected Egyptian thought.

Babylonian culture also influenced early Phoenicia. By the 1300's B.C., the princes of Phoenicia were writing in Babylonian cuneiform (see **Cuneiform**). The Phoenicians learned to seal their documents with Babylonian cylinders and seals. The Babylonians also taught the Phoenicians many of their mythological tales about the beginning of the world, the birth of the gods, and the creation of human beings. Some scholars believe that Phoenicia may have been the channel through which the Babylonian legends about the creation and the flood passed to the Hebrews farther south and to the Greeks.

For a short period in the 1200's B.C., Phoenicia came under the Hittite sphere of influence, but gained its freedom when the Hittite Empire collapsed.

The spread of Phoenician influence. The Phoenician cities gained their independence about 1100 B.C. For the next 250 years, they stood at the height of their power and prosperity. There were Phoenician settlements on the island of Cyprus even before the 1100's B.C. After that date, Phoenician sailors opened up the entire Mediterranean to their ships and commerce. They established colonies along the southern coast of Spain,



Detail of a relief sculpture (700's B.C.); Louvre, Paris (Giraudon/Art Resource)

Phoenician ships transporting wood appear in this ancient Assyrian relief sculpture from Khorsabad in modern Iraq. The Phoenicians were skilled sailors, navigators, and traders.

tl northern coast of Africa, and the western coast of Sily. It may be said that the western Mediterranean vs a "Phoenician lake" before the coming of the Greeks. Penicians influenced Western culture through their cony of Carthage. This greatest of all Phoenician conies in the West was founded by people from the c of Tyre about 750 B.C. Queen Dido was one of the lendary founders of Carthage (see **Dido**). Phoenician conies, including Carthage, resembled the cities of Fenicia. Many manufacturers, industrial workers, merchants, and sailors lived there.

The city of Tyre seems to have played the main part i the colonizing activity of the Phoenicians. A vivid desiption of Tyre's far-flung commerce appears in the d Testament (Ezekiel 27:3-25). When King David of Is-rl established his royal residence at Jerusalem, he uilt his palace with stone and cedars from Lebanon Samuel 5:11). The first book of Kings tells that Hiram, ig of Tyre in the 900's B.C., was a friend of David's sucssor, King Solomon. When Solomon built his famous mple, he asked Hiram for firs and cedars from banon. When Solomon built a navy, Hiram lent him ipmen that had knowledge of the sea" (I Kings 9:27). e base of this fleet was the Red Sea port of Ezion-ber on the Gulf of Aqaba. This site contains the reins of a once great smelting and mining center. Hin and Solomon combined to send from this port eat fleets of merchant vessels, which came back ded with "gold and silver, ivory and apes and peacks" (II Chronicles 9:21). In return, Solomon traded ain, olive oil, wine, and other agricultural products th Hiram.

Some scholars believe that Phoenician influence and rhaps Phoenician colonists reached Corinth and ebes on the mainland of Greece. This tradition of oenician colonization in Greece may be exaggerated. t the Phoenicians appear in the poems of Homer as lled artisans, merchants, and sailors. The Phoenician habet also reached Greece soon after 800 B.C.

Control of both sides of the Strait of Gibraltar gave the oenicians access to the Atlantic Ocean. They establhed a trading monopoly along the coasts of northstern Africa and western Europe. Some scholars beve that the Phoenicians may have sailed as far as rnwall, in southwestern Britain, and worked the tin nes there. Phoenicians sailed around Africa in the 0's B.C., some 2,000 years before the Portuguese did in D. 1497. The Greek historian Herodotus tells this story the fourth book of his *History*.

Decline. The Assyrians captured the Phoenician cities 842 B.C. For the next 200 years, Phoenicia was conlled by Assyria. This period was one of hardship, relt, and suppression. After the downfall of the Assyris in 612 B.C., Phoenicia was briefly controlled by the bylonians. Later, it became part of the Persian Empire eated by King Cyrus I (see **Cyrus the Great**). At this ne, the city of Sidon seems to have surpassed Tyre in portance. Under Persian rule, Phoenician cities prosred and the Phoenicians were still considered excelnt shipbuilders and sailors. During the Persian Wars, 0-479 B.C.), the Phoenician fleet was the strongest arm the Persian Navy in its attack upon Greece. Herodotus ys that in this fleet the king of Sidon ranked second to rxes, the Persian ruler (see **Xerxes I**). But the Phoenician fleet was almost completely destroyed by the Greeks at the Battle of Salamis in 480 B.C.

Phoenicia came under Greco-Macedonian rule when Alexander the Great captured the city of Tyre in 332 B.C. His successors, the rulers of Egypt and Syria, fought among themselves for possession of the Phoenician cities and for control of their shipbuilding and commercial resources. During this period, the culture of Phoenicia changed. Greek gradually became the language of literature and learning. Aramaic, which had earlier replaced the Phoenician language, became the language of the marketplace and of the common people. Many philosophers of the time, including Zeno of Sidon and Diodorus of Tyre, were of Phoenician origin.

In 64 B.C., the Roman general Pompey the Great made Phoenicia part of the Roman province of Syria. The Romans established a famous law school at Beirut. Tyre and Sidon became centers of learning and prospered commercially. Tyre became known for the manufacture of fine glass. Phoenicia and the rest of Syria fell to Muslim invaders in the A.D. 600's. Louis L. Orlin

Related articles in *World Book* include:

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Baal		Utica

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Phoenix, *FEE nihks,* is the capital and largest city of Arizona. It is also a manufacturing center and a major winter-resort area. Phoenix lies in the Salt River Valley, a flat region ringed by low mountains.

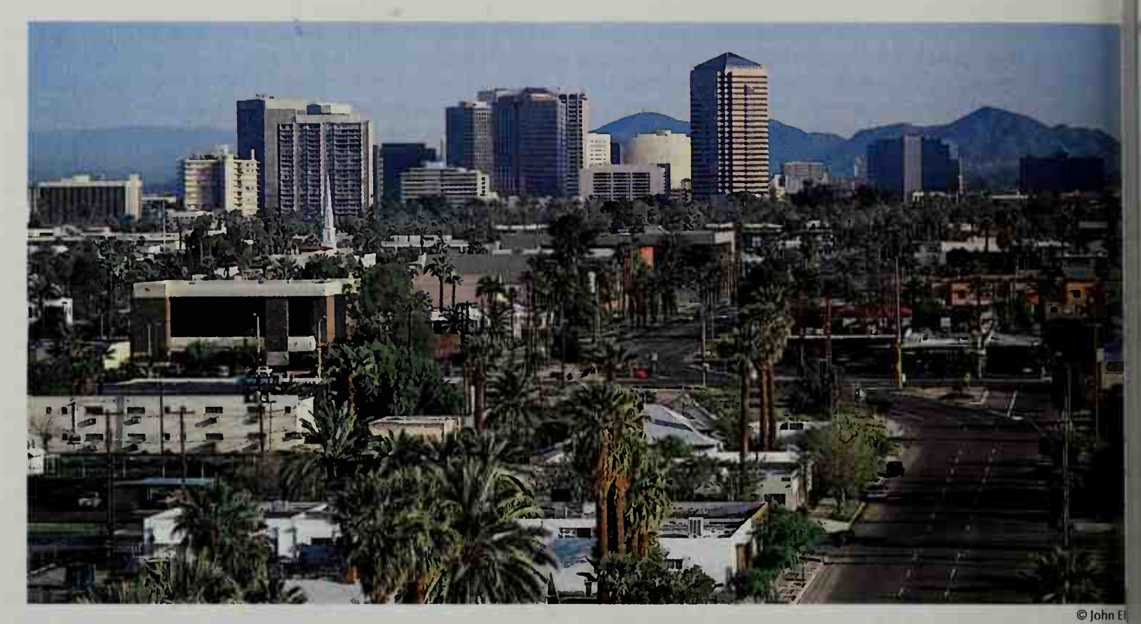
The city has a warm, sunny, dry climate. Winter temperatures may reach 70 °F (21 °C) or higher. The city's climate attracts many visitors. The sun shines about 300 days a year. Early resorts in Arizona once offered visitors free rooms and meals on days the sun did not shine.

White pioneers first settled in the Phoenix area in the 1860's. Two of them, Jack Swilling and Darrel Duppa, noted that an ancient civilization, that of the Hohokam Indians, had once thrived in the valley. Duppa predicted that a great city would rise on the site. He named their settlement *Phoenix* for the mythical bird that rose from its own ashes every 500 years. In the mid-1900's, Phoenix became one of the fastest-growing cities in the United States. In 1950, it ranked 99th in population among the nation's cities. By 1980, it had jumped to 9th. By 2000, Phoenix had become the 6th largest city in the United States. The climate—and the widespread use of air conditioning—helped bring about the rapid growth.

The city

Phoenix and its neighboring communities lie in the broad, flat Salt River Valley, which is surrounded by mountains. The Salt River flows westward through Phoenix and becomes part of the Gila River a few miles southwest of the city. The Salt and Gila are usually dry in the Phoenix area. They have been dammed east of the city to collect water for irrigation.

The Salt River Valley was originally desert, and water has always been a critical need in the Phoenix area.



© John El

Phoenix, the capital and largest city of Arizona, lies in a desert valley ringed by mountains. The city experienced enormous growth in the mid-1900's, partly because of its warm, sunny climate. Office buildings rise in the downtown area, *shown here.*

Since 1986, Phoenix has received water from the Colorado River on Arizona's western border through aqueducts of the Central Arizona Project.

Layout of Phoenix. The city of Phoenix covers 450 square miles (1,165 square kilometers) and is the seat of Maricopa County. Phoenix began as a trading center for a farming district that covered much of the Salt River Valley. Urban growth has eaten up much of the farmland, but the distance between downtown office buildings and farms where cotton, grains, and vegetables grow is still only a few miles.

Downtown Phoenix is near the center of the city. There, high-rise buildings extend along Central Avenue, forming the city's financial district. Downtown also includes City Hall, the Arizona State Capitol, and other government buildings. Also in the area are the Phoenix Civic Plaza, which includes a symphony hall and several large exhibition areas; America West Arena; and Arizona Center, a complex of offices and shops.

Residential areas, with their shopping malls, spread out beyond the downtown area. A few *buttes* (steep hills) pop up in the middle of the urban area. For example, Camelback Mountain rises 2,704 feet (824 meters) in an expensive residential area in eastern Phoenix. Squaw Peak, which rises 2,608 feet (795 meters) in the northern part of the city, is popular for hiking.

The metropolitan area is sprawling and spacious. The residential areas of the city blend into adjoining cities and towns. These communities include Glendale, Paradise Valley, Scottsdale, and Tempe. Mesa lies east of Tempe. It is the area's second largest city.

The Phoenix urban area includes all of Maricopa County. The United States Census Bureau classifies Maricopa County and Pinal County as the Phoenix-Mesa metropolitan area, which covers about 14,600 square miles (37,800 square kilometers). Nearly two-thirds of the people of Arizona live in the fast-growing area, which increased in population by more than 1 million betwee 1990 and 2000.

People

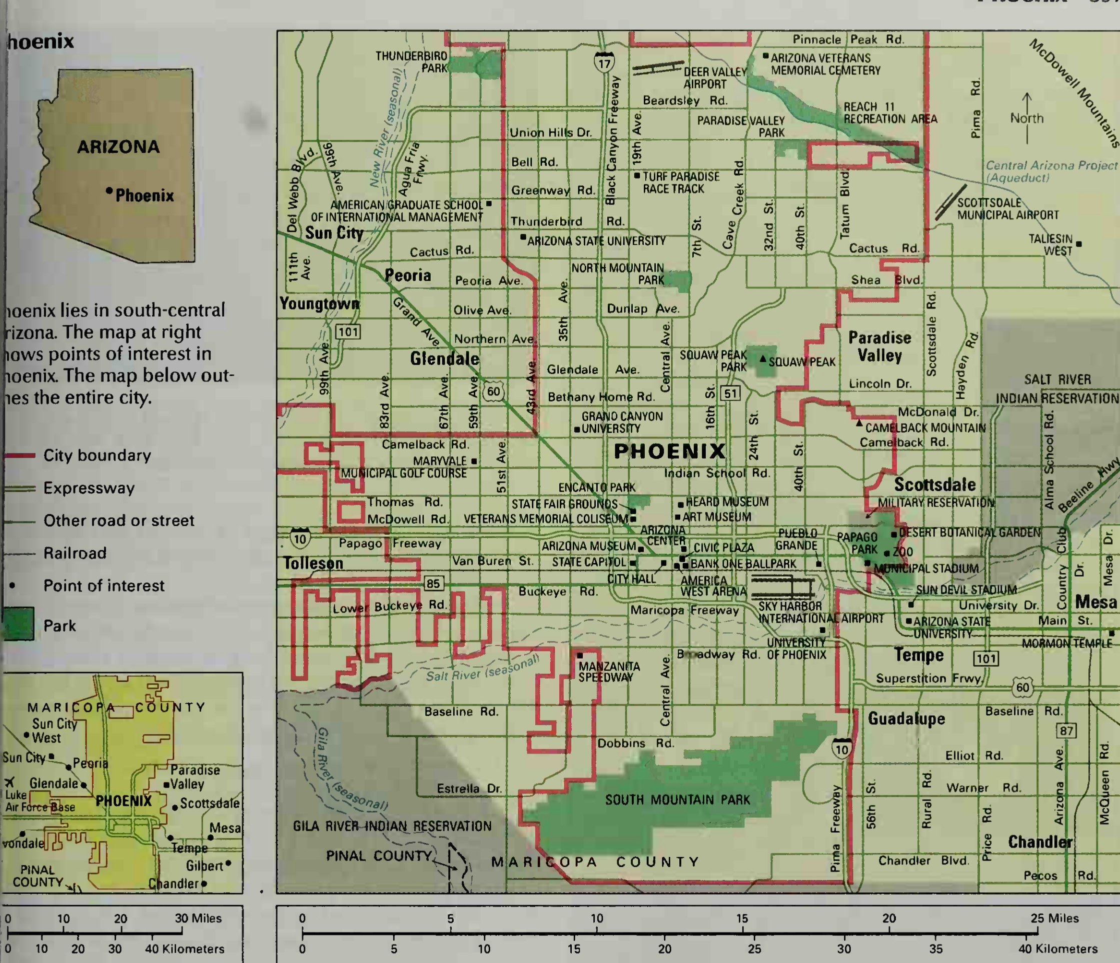
The people of Phoenix are called Phoenicians. The city's climate has drawn many residents from other par of the United States. Only about one-third of the peopl were born in the Phoenix area.

Ethnic groups. Non-Hispanic whites account for about 56 percent of the city's population. Hispanics make up about 34 percent of the population, and African Americans about 5 percent. American Indians and Asians each make up less than 2 percent.

Housing. Phoenix is largely a city of single-family homes. Following World War II (1939-1945), newcomer began flocking to Phoenix. Phoenix contractors bought up farmland and built sprawling subdivisions of single-family homes. In some areas, such as the Maryvale district of west Phoenix, they constructed houses that wer modest and affordable. More expensive housing tende to be concentrated in northeast Phoenix and in adjoining Scottsdale. The largest Hispanic and African-American neighborhoods are in southern Phoenix.

Since the 1960's, retirement communities have addec a new element to the population and housing patterns of the Phoenix area. Such large developments were bui especially for retirees. The largest ones include those a Sun City and Sun City West, northwest of Phoenix, and in the Mesa and Chandler regions in the southeast.

Education. Maricopa County has about 500 public e ementary and high schools, with a total of more than 440,000 students. About 130 parochial schools, with a to tal of more than 19,000 students, also operate in the county. The county has one of the largest systems of two-year community colleges in the nation. Most of Ari



ona's four-year universities and colleges are in the hoenix area. The largest one, Arizona State University, as its main campus in Tempe and a smaller campus in vestern Phoenix. The Frank Lloyd Wright School of Ar-hitecture is located in Scottsdale at Taliesin West.

Social problems. Violent crime is a problem in hoenix, as in other large urban areas. Much of the rime is associated with gang activity and drug abuse.

Phoenix also is plagued by air pollution, much of vhich results from automobile exhaust. The only form of nass transportation is a bus system that draws relatively ew riders. Most residents drive cars.

Cultural life

The arts. Phoenix is the home of the Phoenix Sym-ıhony Orchestra, the Arizona Theater Company, and ıallet Arizona. The area's major theaters include the Her-ıerger Theatre Center in downtown Phoenix, Symphony ıall in Phoenix Civic Plaza, the Sundome in Sun City, and Grady Gammage Auditorium at Arizona State University n Tempe. The auditorium, completed in 1964, was the ast major public building designed by architect Frank loyd Wright.

Museums and libraries. The Heard Museum of An-hropology and Primitive Art in Phoenix concentrates on American Indian culture. The collection of the Phoenix Art Museum includes European and Asian art and contemporary art of the U.S. Southwest. The Phoenix Museum of History chronicles the settlement and growth of Phoenix. The nearby Scottsdale Center for the Arts exhibits contemporary and historical art.

The Phoenix Public Library has 11 branches. Maricopa County maintains 11 libraries throughout the county.

Recreation. Many Phoenix residents enjoy outdoor life, which the mild climate favors. Popular activities include trips to nearby mountains and boating on lakes built to store irrigation water. The metropolitan area has about 100 golf courses.

The Phoenix Zoo is located in Papago Park, an area of stone buttes on the border between Phoenix and Tempe. The Desert Botanical Garden, also in the park, features plants native to deserts throughout the world. Phoenix South Mountain Park, in southern Phoenix, is the largest municipal park in the United States. It covers over 16,500 acres (6,677 hectares).

The Phoenix Suns of the National Basketball Association and the Phoenix Coyotes of the National Hockey League play in the America West Arena. The Arizona Diamondbacks of the National League play baseball in Bank One Ballpark. The Arizona Cardinals of the National Football League play in Sun Devil Stadium in Tempe. Phoenix International Raceway, in Avondale, features au-

Facts in brief

Population: *City*—1,321,045. *Metropolitan area*—3,251,876.
Area: *City*—450 mi² (1,165 km²). *Metropolitan area*—14,600 mi² (37,800 km²).
Climate: *Average temperature*—January, 54 °F (12 °C); July, 94 °F (34 °C). *Average annual precipitation* (rainfall, melted snow, and other forms of moisture)—8 in (20 cm). For the monthly weather in Phoenix, see **Arizona** (Climate).
Government: Council-manager. *Terms*—4 years for the mayor. For the 8 council members, 2 years for the first term, and 4 years for following terms. The council hires the manager.
Founded: 1870. Incorporated as a city in 1881.

Largest communities in the Phoenix area

Name	Population	Name	Population
Phoenix	1,321,045	Tempe	158,625
Mesa	396,375	Gilbert	109,697
Glendale	218,812	Peoria	108,364
Scottsdale	202,705	Sun City*	38,309
Chandler	176,581	Avondale	35,883

*Unincorporated.
Source: 2000 census.





Symbols of Phoenix. Both the city's flag, *left*, and its seal, *right*, feature the phoenix, the mythical bird for which the city is named. The flag was adopted in 1990. The seal includes the date on which Phoenix was incorporated as a city.

tomobile races. Turf Paradise Race Track, in northern Phoenix, hosts a winter season of horse races.

Major annual events recall the area's Western heritage. They include the Phoenix Jaycees Rodeo of Rodeos and the Arizona National Livestock Show.

Economy

Service industries, particularly tourism and government activities, play a key role in the economy of the Phoenix area. Manufacturing also contributes heavily to the economy.

Service industries. Tourists flock to the Phoenix area. Many vacation resorts, golf courses, and other tourist-related facilities operate there. Tourism generates much income and employment. It is a year-round industry. But the tourist facilities are busiest during winter, when visitors come to escape cold weather back home.

Other service industries include government and military activities. State, county, and city governments operate in Phoenix and provide many jobs. Luke Air Force Base, at Glendale, also contributes to the economy.

Manufacturing. The Phoenix area's chief manufactured products include aircraft, aircraft engines and parts, computers, guidance and navigation equipment,



© John Elk III

Outdoor recreation is popular in the Phoenix area. The area has about 100 golf courses, open the year around. The mild winter climate makes Phoenix a major winter resort center.

and semiconductors. The area's products also include agricultural chemicals, air-conditioning equipment, and cosmetics.

Transportation and communication. Phoenix Sky Harbor International Airport ranks among the nation's busiest airports. It is home base of America West Airlines. Passenger and freight railroad lines and more than 150 trucking companies serve the city. Phoenix has one daily newspaper, *The Arizona Republic*.

Government

Phoenix has a council-manager form of government. The voters elect a mayor and eight city council members. The mayor serves a four-year term. The council members are elected initially to a two-year term, and they may be reelected to four-year terms. The council hires a city manager to carry out its policies, to prepare the city budget, and to appoint and dismiss department heads.

History

Settlement. Hohokam Indians lived in the Salt River Valley from about 300 B.C. until the 1400's. They constructed a system of canals to take water from the Salt



Honeywell Inc

Factory workers in Phoenix assemble electronic parts for a space shuttle. Manufacturing ranks as the most important economic activity in Phoenix.

d Gila rivers to irrigate their crops. In 1539, Spanish plorers became the first whites to reach the area. The ea belonged to Spain from 1539 until 1821, when it as taken over by Mexico. The area became part of the ited States in 1848, when the U.S. defeated Mexico in e Mexican War.

The Phoenix area was part of the New Mexico Territo- from 1850 until 1863, when the U.S. government creat- the separate Territory of Arizona. Prescott, in the rthern part of the territory, became the capital.

In 1865, the United States established a military post med Camp McDowell northeast of the future site of oenix to protect the road between Tucson and escott. Farmer John Y. T. Smith settled in the area and ew hay to sell to the Army at Camp McDowell. Mari- pa and Pima Indians lived in the area at that time.

In 1867, adventurer Jack Swilling led a party of men to e Salt River Valley to build new irrigation canals. In me places, the men simply dug out the old Hohokam nals. Swilling's group included Englishman Darrel uppa, who gave the settlement the name *Phoenix.* owever, Swilling's settlement was about 4 miles (6.4 ometers) east of what became the official site of oenix. In 1870, settlers selected and surveyed the offi- al town site, in what is now the downtown area, mark- g the founding of Phoenix. Phoenix was incorporated a city in 1881.

Early developments. Because of the mild winters d year-round growing seasons, Phoenix prospered d other towns were established nearby. Branch rail- ads connected Phoenix to the Southern Pacific (now nion Pacific) Railroad's main line in 1887 and to the nta Fe's main line (now part of Burlington Northern nta Fe Corporation) in 1895. The city became a center r trading and processing farm products.

The Salt River caused problems. At times, it was near- dry; but at other times it flooded and carried away rms and houses in low-lying parts of the city. In the rly 1900's, builders constructed Theodore Roosevelt am 55 miles (86 kilometers) northeast of Phoenix to ntrol the Salt's flooding and to store water until it was eded to irrigate crops. The dam began operations in 11. It assured the city a steady supply of water. Devel- pers began to attract more settlers to the area.

Phoenix was named the capital of the Territory of Ari- na in 1889. Arizona became a state in 1912, and oenix remained the capital. By 1920, Phoenix, with a pulation of 29,053, had become Arizona's largest city.

The Phoenix area's first resort for winter visitors, the gleside Inn, opened in 1910. The winter tourist trade gan to flourish.

Dramatic growth. The growth of Phoenix was steady ut modest until the beginning of the 1940's. In 1940, the pulation had reached 65,414. Phoenix then entered a riod of tremendous growth.

During World War II, the armed forces used the oenix area for training in aviation and desert warfare. fter the war ended in 1945, many former members of e military who had trained in Arizona returned to the oenix area to live and to raise families.

Beginning in the 1950's, air conditioning became com- on in the United States. Summer temperatures in oenix often reach 100 °F (38 °C) or higher. Air condi- oning made living in the desert climate of Phoenix more comfortable. Large numbers of retired people be- gan to move to the area. The establishment of new in- dustries in Phoenix also contributed to the city's growth. This development was part of a national trend of indus- trial growth in the so-called *Sun Belt,* or areas with warm climates.

Phoenix steadily annexed surrounding areas to allow for continued growth. In 1950, the city covered only 17 square miles (44 square kilometers). Its size has since in- creased to 450 square miles (1,165 square kilometers). The annexations also resulted in population growth. To accommodate the population, thousands of single-fami- ly dwellings were built on former farmland and even in parts of the desert.

The population of Phoenix reached 106,818 by 1950. Then, in just 10 years, the population quadrupled—soar- ing to 439,170 in 1960. In 1950, Phoenix had ranked as the 99th largest U.S. city in population. By 1980, with 789,704 people, the city ranked 9th.

Recent developments. Through the years, outside sources of water have been necessary for the continued growth of Phoenix. In 1968, the United States Congress authorized funds to build the Central Arizona Project. This project was designed to bring water from the Col- orado River along Arizona's western border to Phoenix and other parts of the state. Phoenix began receiving wa- ter from the project in 1986.

During the 1950's and 1960's, downtown Phoenix lost many of its businesses when companies moved to new suburban shopping malls. However, since the 1970's, the city has redeveloped much of its downtown area. Builders completed a new city hall in 1993 and a new central library in 1995.

The Phoenix area has continued to grow. By 2000, the city's population had reached 1,321,045. Outlying com- munities also grew, and Phoenix is now the hub of a metropolitan area of more than 3 $\frac{1}{4}$ million people.

James E. Cook

See also **Arizona** (pictures).

Phoenix, *FEE nihks,* was a fabled bird in Greek mythol- ogy. Only one such bird existed at any time, and it was always male. It had brilliant gold and reddish-purple feathers, and was as large or larger than an eagle. Ac- cording to some Greek writers, the phoenix lived exactly 500 years. Other writers believed its life cycle was as long as 12,954 years.

At the end of each life cycle, the phoenix burned itself on a funeral pyre. Another phoenix then rose from the ashes with renewed youth and beauty. The young phoenix, after rising from the ashes, carried the remains of its father to the altar of the sun god in the Egyptian city of *Heliopolis* (City of the Sun). The long life of the phoenix, and its dramatic rebirth from its own ashes, made it a symbol of immortality and spiritual rebirth.

The Greeks probably took their idea of the phoenix from the Egyptians, who worshiped the *bennu,* a sacred bird similar to the stork. The bennu, like the phoenix, was connected with the sun worship rites in Heliopolis. Both birds represented the sun, which dies in its flames each evening and emerges each morning.

Mary R. Lefkowitz

Phonetics, *foh NEHT ihks* or *fuh NEHT ihks,* is the sci- ence of speech sounds and the symbols by which they are shown in writing and printing. This science is based

on a study of all the parts of the body concerned in making and hearing speech. It includes the positions of the parts of the body necessary for producing spoken words, and the effect of air from the lungs as it passes through the larynx, pharynx, vocal cords, nasal passages, and mouth. Phonetics also deals with the physical properties of sound—such as *frequency* and *amplitude*—that permit people to hear speech sounds as different from one another. For a discussion of these properties, see **Sound** (The nature of sound).

An international phonetic alphabet is used to represent speech sounds symbolically. The symbols can be applied to all languages. In English, they show the difference between the *th* of *ether* (θ) and the *th* of *either* (ð), and between the *ssi* of *mission* (ʃ) and the *si* of *vision* (ʒ). Another symbol shows the *ng* sound of *sing* (ŋ). Phonetic symbols are especially useful for vowel sounds, as in the *a* of *father* (ɑ) and the *a* of one pronunciation of *ask* (a),or the *u* sound of *pull* (ʊ), the *oo* sound of *pool* (u), and the stressed *u* sound of *sun* (ʌ). The most common sound in the English language is that of *e* in ag*e*nt. It appears in print as *a*round, mom*e*nt, char*i*ty, porp*oi*se, act*o*r, and circ*u*s. Its symbol is an inverted *e* (ə), *called a schwa.*

Phonetics and spelling. The *phonetic ideal* is the term for a language in which every spoken sound is represented by one letter and only one. No language has reached this ideal. German and Spanish add a few marks to letters, because those languages have too few letters to cover all their sounds. Italian has only one silent letter, *h*, which is used before *e* and *i* to make the preceding *g* or *c* hard, as in *spaghetti.* French is among the most complex in this respect. It has many spellings for the same sound; four accent marks; and a cedilla for words like *François* that have an *s* sound for *c.*

English spelling was decided on by printers hundreds of years ago, but speech has continued to change. For this reason, English is far from the phonetic ideal. "*Though* he pulled *through* a *cough* and *hiccough,* he still had a *rough* night on a *bough,*" contains six different sounds spelled the same. Every vowel has several sounds, as in c*a*ke, h*a*t, and *a*rm. *A* and *e* have about eight sounds. English-speaking people have tried in some ways to reproduce sounds phonetically. For example, *pin* and *pine,* and *pinning* and *pining,* mark the difference in the *i* sounds. But there is no reason for a spelling difference in *till* and *until.*

Many people have sought to establish a *reformed spelling,* to bring spelling closer to sound. However, such a reform would be of doubtful value because pronunciation changes so rapidly. Marianne Cooley

See also **Pronunciation.**

Phonics, *FAHN ihks,* is the association of letters or combinations of letters with their appropriate speech sounds. Phonics also includes understanding the principles that govern the use of letters in words. In reading, phonics helps us understand the sound of a word that is unfamiliar. In spelling, phonics helps us write the appropriate letters for the sounds we hear.

Phonics can be taught synthetically or analytically. In the *synthetic* approach, a child learns the sounds of individual letters and letter combinations, usually before learning to read. With an unfamiliar word, the child *synthesizes,* or sounds out, the sounds that make up the word. In the *analytic* approach, a child develops a vocabulary of words he or she knows by sight. This is done while learning to read. The child eventually analyzes the words for their sounds. In this way, the child understands both the sound of the letters and the reasons some letters are used instead of others. The child then applies these reasons, or *principles,* and learns to recognize the sounds of new words.

In reading, phonics has both advantages and limitations. A knowledge of phonics makes it possible to reconstruct the sounds of many words not known by sight. This is particularly true for languages in which each letter or symbol represents only one sound and each sound is represented by only one letter. In the English language, the relation between sounds is not consistent. Thus, phonics has limitations if it is the only means used to learn unfamiliar words. Different letters may represent the same sound, as in *meet* and *meat,* or the same letter may stand for different sounds, as the *a* in *fall* and *fate.*

Educators consider phonics an essential part of any effective reading program. But because of the many inconsistencies in the English language, they recommend using additional aids to help a reader improve his or her pronunciation of unfamiliar words. For example, the reader may be taught to identify new words by their prefixes, suffixes, roots, and syllables. Marianne Cooley

See also **Phonetics; Pronunciation; Reading.**

Phonograph is a device that reproduces sounds that have been recorded on audio records. Phonographs are also called *record players.* Until the mid-1980's, they were the most common device for listening to music and other sound recordings. Today, most people have replaced their record collections with cassette tapes and compact discs. Compact disc players produce better sound than phonographs do. Compact discs also are more durable than records. However, many people still use phonographs to listen to older recordings.

How phonographs work. Phonographs play records that have been produced by a process called *analog disc recording.* In this process, an *analog* (likeness) of the original sound waves is stored as jagged waves in a spiral groove on the surface of a plastic disc. As the disc rotates on the phonograph, a needle, called a *stylus,* rides along the groove. The waves in the groove cause the stylus to vibrate. These vibrations then are transformed into electric signals and converted back into sound by speakers.

Most phonograph records are thin plastic discs with a diameter of 7 or 12 inches (18 or 30 centimeters). A 7-inch record is played at a speed of 45 revolutions per minute (rpm) and has only a few minutes of sound per side. A 12-inch *long-playing* (LP) record is played at $33\frac{1}{3}$ rpm and holds about 30 minutes of sound per side. A 12-inch single holds several minutes of sound per side and is also generally played at $33\frac{1}{3}$.

Parts of a phonograph. There are six main parts of a phonograph. These parts are: (1) the turntable, (2) the drive system, (3) the stylus, (4) the cartridge, (5) the tone arm, and (6) the amplifier.

The turntable is a flat metal plate covered with rubber on which the record sits. Most turntables operate at 33 and 45 rpm. Some turntables also operate at 78 rpm, a playback speed used in making records until the 1950's.

The drive system spins the turntable. Most phono-raphs are equipped with a *direct drive.*

In a direct drive system, the turntable is mounted di-ectly on the motor shaft. The speed of the motor, which an be varied, determines the speed of the turntable's otation.

The stylus is a piece of diamond or extremely hard ynthetic material shaped somewhat like a cone. The sty-us is suspended from one end of a flexible strip of met-. The other end of the metal strip is attached to the car-idge.

The stylus vibrates as it rides in the groove of a ecord. In a stereophonic phonograph, the stylus re-ponds to two separate sets of waves—one on either de of the groove. These two sets of waves correspond the two stereo sound channels.

The cartridge receives vibrations from the stylus and ansforms them into electric energy. Most cartridges enerate voltages when the motion of the stylus moves n electric coil in a magnetic field or moves a magnet ear a coil. A stereophonic cartridge changes the stylus ibrations into two sets of electric signals—one for the ght sound channel and one for the left.

The tone arm, also called the pickup arm, holds the artridge and stylus. In most record players, the tone rm is mounted on a pivot. The pivot lets the stylus ride e record groove in an arc across the disc. The pres-ure of the stylus is controlled by a weight at the pivot nd of the tone arm. Too much pressure causes poor ound quality and increased record wear. If there is too ttle pressure, the stylus will skip across the record. Vires along the tone arm carry electric signals from the artridge to the amplifier.

The amplifier boosts the power of the weak signals om the cartridge so that they reach the speakers in suf-cient strength. The speakers convert the electric sig-als to sound waves (see **Speaker**).

How phonograph records are made. The produc-on of most records begins with making a *master* (origi-al) tape recording in a studio or concert hall. Such ecordings are made using tape recorders capable of ecording many separate *tracks* (channels of sound). In roducing the master tape, an engineer records differ-nt instruments or groups of instruments on separate acks. During recording, various aspects of sound qual-y can be controlled separately for each track. In addi-on, each track can be recorded and played back alone or in combination with other tracks. See **Recording industry** (In a recording studio).

Often, the engineer records several *takes* (separate recordings) of a section of music. After recording, the editing engineer selects the best take of each section of music. The engineer edits the music electronically to create a new master tape. The new tape has the sections from different takes arranged as though they had been recorded in a single performance. The engineer uses a process called *mixdown* to reduce the number of tracks to the two needed for a stereophonic record.

The next step in making a phonograph record is the creation of a master lacquer. A lacquer is an aluminum disc coated with nitrocellulose lacquer. A blank lacquer is rotated on the turntable of a machine called a *record-cutting lathe.* Electric signals from the master tape are fed to a *cutting head* on the lathe. A *cutting stylus* on the cutting head cuts a wavy, V-shaped groove that spirals toward the center of the disc. This stylus is connected to two electric coils. Each electric coil is near a separate electromagnet.

In making a stereo lacquer, electric signals corresponding to the right channel magnetize one coil. Those corresponding to the left channel magnetize the other coil. The magnetic changes in the coils cause the stylus to move up and down and from side to side. The stylus thus cuts waves for the left channel on one side of the groove, and it cuts waves for the right channel on the other.

Next, a *metal master* is made from the master lacquer by a process called electroplating (see **Electroplating**). In this process, the surface of the master lacquer is coated with nickel. When separated from the lacquer, this nickel plate forms a metal master—a negative copy that has ridges where the lacquer has grooves. Plating the metal master produces a *mother*—a positive copy of the lacquer. The mother itself is then plated several times to create multiple negative copies called *stampers.*

Two stampers, one for each side of the disc, are mounted in a hydraulic press. A piece of plastic called a *biscuit* is placed between the stampers and squeezed in the press. Steam circulating through the press softens the plastic, which is imprinted with record grooves from both stampers. After the record is imprinted, cool water stiffens the disc.

History. The first practical phonograph was invented in 1877 by the U.S. inventor Thomas A. Edison. Edison's

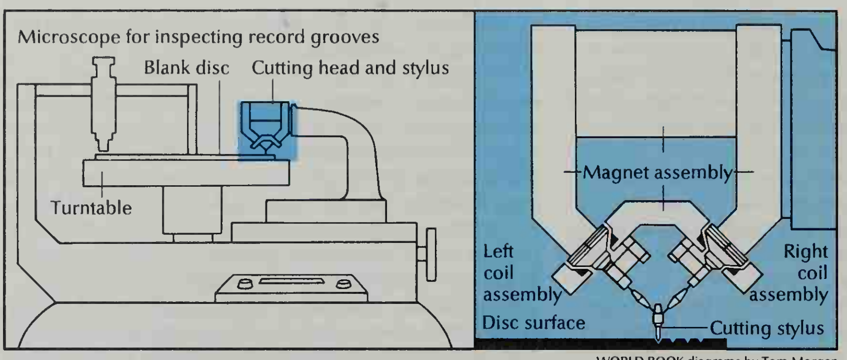
WORLD BOOK diagram by Tom Morgan

Tone arm
Stereo cartridge and stylus
Turntable and record
Left channel
Stereo amplifier
Right channel
Left speaker
Right speaker

© Tony Brain, SPL from Photo Researchers



A stereophonic phonograph, *far left,* reproduces two sound channels from a single record groove. The stylus rides in the groove of a record. A photograph of the magnified grooves on a record, *left,* shows the waves that make the stylus vibrate. The cartridge changes the vibrations into two sets of electric signals. The amplifier strengthens the signals, and the speakers turn them into sound.



Cutting an original disc is done on a cutting lathe, *far left.* The stylus in the cutting head cuts a groove in a blank disc revolving on the turntable. A stereo cutting head, *left,* has two coil assemblies that are magnetized separately by electric signals from each channel on a master tape recording. These magnetic changes move the stylus so that it cuts a groove with waves for both channels.

WORLD BOOK diagrams by Tom Morgan

device could record sound on tinfoil wrapped around a small metal cylinder, and then replay the sound. The cylinder rotated on an axle that was turned with a hand crank. A needle attached to a *diaphragm* (vibrating disc) was placed against the cylinder. As someone spoke into a mouthpiece, the sound waves made the diaphragm and needle vibrate. These vibrations caused the needle to make dents in the foil on the rotating cylinder. To play back the sound, another needle attached to a diaphragm was placed against the cylinder. As the cylinder was rotated, the dents in the foil made the needle and diaphragm vibrate. These vibrations created sounds roughly like the original sound. This type of recording is called *acoustic recording* because the sound is produced without electrical energy.

In 1885, the U.S. scientists Chichester Bell and Charles S. Tainter improved upon Edison's invention by recording on cardboard cylinders coated with wax. This new recording material produced better sound.

In 1887, Emile Berliner, a German immigrant to the United States, invented the Gramophone—a phonograph that used shellac discs. These discs provided better sound, were more durable, and could be mass-produced more easily than could cylinders.

The first electrically recorded phonograph records appeared in 1925. In addition, manufacturers began producing phonographs with electric motors and amplifiers, which greatly improved the quality of recorded sound.

Until 1948, most commercial disc recordings were made of a mixture of clay and shellac and were played at 78 rpm. In that year, the plastic 33 $\frac{1}{3}$-rpm LP record appeared on the market. It had been developed at the Columbia Broadcasting System Laboratories under the direction of Peter Goldmark, a U.S. electrical engineer. The LP held much more recorded sound and was more durable than the 78-rpm disc. In 1949, the 45-rpm disc was introduced by Radio Corporation of America (now RCA Corporation) to compete with the LP.

Growing interest in high fidelity in recorded sound led to the appearance of stereophonic phonographs and discs in 1958. Previously, records and phonographs were *monaural,* or monophonic. Such records and record players reproduce sounds from only one channel. By the late 1960's, almost all new phonographs and records were stereophonic.

Audio compact discs were introduced in Japan and Europe in 1982, and in the United States in 1983. Their superior sound quality and durability quickly made them popular. Today, few new recordings are issued on phonograph records. Ken C. Pohlmann

Related articles in *World Book* include:

Berliner, Emile
Compact disc
Edison, Thomas A.
Recording industry
Speaker
Stereophonic sound system
Tape recorder

Additional resources

Kenney, William H. *Recorded Music in American Life: The Phonograph and Popular Memory, 1890-1945.* Oxford, 1999.
Millard, Andre. *America on Record: A History of Recorded Sound.* Cambridge, 1995.
Steffens, Bradley. *Phonograph: Sound on Disk.* Lucent Bks., 1992. Younger readers.
Welch, Walter L., and Burt, L. B. S. *From Tinfoil to Stereo: The Acoustic Years of the Recording Industry, 1877-1929.* Univ. Pr. of Fla., 1994.

Phosphate, *FAHS fayt,* is any chemical compound that contains the phosphate group. The phosphate group consists of one phosphorus atom and four oxygen atoms. Its chemical formula is PO_4^{3-}.

In living organisms, cells use compounds containing phosphates to store and release energy. Phosphates are also part of DNA (deoxyribonucleic acid) and RNA (ribonucleic acid), the substances that determine a cell's form and function. In addition, the phosphate mineral hydroxyapatite is an important part of bones and teeth.

There are large amounts of natural phosphates. They occur in phosphate rocks and in the remains of organisms. The main commercial sources of phosphate rock include deposits in China, Morocco, Russia, and the United States. Processors use most phosphate rock to produce fertilizers. They crush the rock to make dry fertilizers. They make superphosphate, a liquid fertilizer that acts much faster than the pulverized rock, by treating the crushed rock with sulfuric acid.

At one time, phosphates were widely used in the manufacture of detergents. The phosphates help remove dirt and soften hard water. Unfortunately, detergents in waste water carry phosphates into lakes and streams, where the compounds cause algae to multiply. As the algae die, the process of their decay uses up oxygen needed by fish and other aquatic life. This problem led some U.S. cities and states to ban phosphate detergents. Emily Jane Rose

See also **Fertilizer; Detergent and soap.**

Phosphorescence, *FAHS fuh REHS uhns,* is the light certain substances give off when they absorb energy. The general term for the emission of light due to the absorption of energy is *luminescence.* The term *phospho-*

scence refers to luminescence that continues after the
ergy source has been removed. It may last for sec-
ds, hours, or even days. Luminescence that occurs
ly while a substance is exposed to energy is called *flu-
escence.* See **Fluorescence; Luminescence.**
The energy to create phosphorescence may be sup-
ed by various sources, including electric current, ul-
violet rays, X rays, and certain chemical reactions. The
lor of the phosphorescent light depends on the sub-
nce and the form of energy it absorbs.
Familiar phosphorescent substances include cellu-
d, eggshells, ivory, and paraffin. Many gems, miner-
, and pigments phosphoresce strongly when excited
nuclear or ultraviolet radiations. Some materials
osphoresce simply by being exposed to sunlight.
anufacturers may use such materials in toys or the
rkings on watch faces that glow in the dark. The
osphorescence given off by living things is called *bio-
minescence* (see **Bioluminescence**).
For a substance to phosphoresce, the electrons in its
ms must absorb energy. This energy causes the elec-
ns to become *excited*—that is, to jump to a higher en-
gy level. Excited electrons are unstable. To drop back
their normal energy level, the electrons give off the
cess energy as light. But in a phosphorescent sub-
nce, the electrons become trapped temporarily be-
een the excited energy level and the normal level.
Phosphorescence serves as a valuable tool in the sci-
tific examination of various materials. For example,
ysicians can diagnose certain diseases by studying
phosphorescent light given off by human tissue ex-
sed to ultraviolet rays. Archaeologists can learn the
e of pottery by heating the pottery and measuring the
ount of phosphorescence that results.
Phosphorescent substances are used to create the im-
es on computer and television screens. Tiny dots of
osphorescent material called *phosphors* coat the
eens. They phosphoresce briefly when a beam of
ctrons strikes them. We see a continuous picture as
the beam sweeps back and forth across the screen.

David M. Roessler



Zenith Radio Corporation

sphor materials, used in color television picture tubes,
v with different colors when struck by streams of electrons.

Phosphoric acid, *fahs FAWR ihk,* is the most common acid of phosphorus. Manufacturers use it to make inorganic phosphate compounds, fertilizers, soft drinks, and flavoring syrups. Its normal sodium salt, Na_3PO_4, is an excellent water softener. Metal surfaces treated with phosphoric acid are highly resistant to corrosion.

Most phosphoric acid is made by one of two processes. In the wet process, naturally occurring phosphate minerals are treated with sulfuric acid. In the thermal process, pure phosphorus is burned to make phosphorus pentoxide, P_2O_5, which produces the acid when dissolved in water. Pure phosphoric acid forms colorless crystals that melt at about 42.4 °C. It is very soluble in water. Phosphoric acid is called *orthophosphoric acid.* Its chemical formula is H_3PO_4.

Marianna A. Busch

Phosphorus, *FAHS fuhr uhs,* is a nonmetallic chemical element. It is found in every living cell and has many industrial uses. In nature, phosphorus occurs only in compounds called *phosphates.*

Plants and animals need phosphorus to live, as well as for normal growth. Plants absorb phosphorus from soil and use it in photosynthesis. People and animals take in phosphorus by eating plants and such foods as meat, milk, and eggs. About four-fifths of the phosphorus in the human body occurs in the bones and teeth. Phosphorus makes up an important part of *adenosine triphosphate* (ATP), a compound that stores energy in body tissues.

A chief source of phosphorus for industrial use is *phosphate rock,* also called *phosphorite.* The countries that mine much phosphate rock include China, Morocco, and the United States. Manufacturers make two forms of phosphorus from phosphate rock. These forms are *white phosphorus* and *red phosphorus.* They are called *allotropes* of phosphorus (see **Allotropy**).

White phosphorus is a soft, waxy solid. To prepare it, manufacturers first produce phosphorus vapor by heating phosphate rock in the presence of coke and sand. The vapor is then condensed into white phosphorus. White phosphorus combines readily with other elements. It also spontaneously ignites in air at about room temperature. For this reason, white phosphorus is usually stored underwater. White phosphorus is very poisonous and, when touched, can cause serious burns. It is also *phosphorescent*—that is, in the dark, it glows when exposed to air. Manufacturers use white phosphorus in making such products as steel, plastics, insecticides, fertilizers, drugs, animal feed, water softeners, and detergents. Detergents made with white phosphorus are rich in phosphates. But phosphates from the detergents can enter lakes and rivers through sewage and contribute to the *eutrophication* of the lakes and rivers. Eutrophication results in the death of fish and other aquatic life (*see* **Eutrophication**).

Red phosphorus, a brownish-red powder, is made by heating white phosphorus or by exposing it to sunlight. Red phosphorus does not burn, or combine with other elements, as readily as white phosphorus. Red phosphorus is used in the production of safety matches and pesticides.

Another allotrope of phosphorus, called *black phosphorus,* resembles graphite. It can be made by heating

white phosphorus under very high pressure. Black phosphorus combines less readily with other elements than do white and red phosphorus.

Phosphorus has the chemical symbol P. Its atomic number is 15, and its weight is 30.973762. White phosphorus melts at 44.1 °C and boils at 280 °C. The German alchemist Hennig Brand discovered phosphorus in 1669.

Marianna A. Busch

See also **Isotope** (diagrams); **Phosphate; Phosphoric acid; Phosphorus cycle.**

Phosphorus cycle, *FAHS fuhr uhs,* is the circulation of phosphorus among the rocks, soil, water, and plants and animals of the earth. Human beings and all other organisms must have phosphorus to live. In nature, most phosphorus occurs in *phosphate rock,* which contains phosphate ions (PO_4^{3-}) combined with calcium, magnesium, chlorine, and fluorine. Phosphate rock forms as sediments at the bottom of the oceans. Some of these sediments are eventually returned to land by movements of the earth's crust.

The weathering of phosphate rock that has been elevated above sea level supplies phosphates to the soil. Plants absorb dissolved phosphate from the soil. Human beings and other animals obtain phosphorus from the plants or animals that they eat. After plants and animals die, certain bacteria break down the dead organic matter and return phosphorus to the soil. Organisms may recycle phosphorus many times before it is finally washed to the sea and is trapped once again in marine sediments.

Human beings accelerate the weathering process by clearing forests and many cultivated areas that protect land from erosion. People also accelerate the phosphorus cycle by mining phosphate rock for the manufacture of such products as detergents and fertilizers. The use of these products greatly increases the rate at which phosphorus returns to the sea. Large quantities of phosphate that come from detergents and fertilizers contribute to water pollution. See **Phosphate.**

William A. Reiners

See also **Phosphorus; Ecology** (Cycling of materials).

Phossy jaw. See **Match** (The first matches).

Phot. See **Foot-candle.**

Photius, *FOH shee uhs* (A.D. 820?-891?), a noted Byzantine scholar and clergyman, became patriarch of Constantinople (now Istanbul, Turkey) in 858. Under the leadership of Photius, a meeting of Eastern patriarchs in 867 challenged papal authority in the Balkans and denounced the pope. This dispute began the great argument between the Greek and Roman Catholic churches that later ended in their separation.

In addition, Photius was known for his digest of the writings of classical Greek authors. The *Myriobiblion* (also called the *Bibliotheca*) is a collection of extracts from, and criticisms and abridgments of, 280 volumes by classical authors. Many originals of these writings ar now lost. Photius was born in Constantinople.

Eugene TeSelle

See also **Eastern Orthodox Churches; Patriarch.**

Photocathode. See **Image orthicon.**

Photochemistry is a branch of chemistry that deals with the chemical reactions that result when the molecules of a substance absorb light. A molecule changes photochemically only if it absorbs light, not if light pass es through it or is reflected.

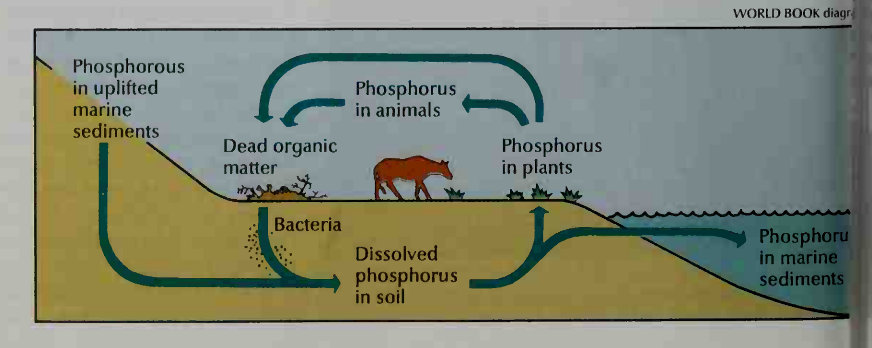
Light is absorbed in tiny packets of radiant energy called *photons.* The energy of a photon depends on the wavelength of the light. After absorbing a photon, a mo ecule increases in energy and is in an *excited state.* In most cases, the molecule remains in that state only a millionth of a second or less. Sometimes the molecule returns directly to its normal state by releasing the ener gy as light or by losing the energy in collisions with oth er molecules. At other times, the molecule has gained enough energy to undergo unusual chemical reactions while in the excited state. These reactions occur when the molecule absorbs visible or ultraviolet light, which has a short wavelength.

Photochemical reactions are part of many natural processes. In photosynthesis, for example, green plants absorb sunlight. The plants use this light energy to mak food out of carbon dioxide from the air and water from the soil (see **Photosynthesis**). Plants thus convert light energy into the chemical energy of food. Through geological processes, plants may be converted into coal or petroleum. As these fuels are burned, the light energy stored in the plants millions of years before is released.

Many industrial processes also involve photochemical changes. In photography, for example, some of the silver salts in photographic film absorb light when a pic ture is taken. The absorbed light chemically changes these salts into metallic silver. When the film is developed, the metallic silver produces a dark image on the negative.

Much research in photochemistry today involves the development of technological uses of solar energy. Some photochemists are seeking ways to imitate the process of photosynthesis with artificially created mole cules. These chemists hope to convert sunlight into electricity in a more efficient way than is now possible.

WORLD BOOK diagr



The phosphorus cycle
The phosphorus cycle is slow and irregular because it takes hundreds of millions of years for movements of the earth's crust to return sediments to land. In addition, these movements occur at different rates at different places.

her photochemists are studying methods for using
nlight to produce such fuels as hydrogen gas and
thanol. Some of these methods involve splitting mol-
ules of water with solar photons. Marye Anne Fox

See also **Light**; **Photon**; **Quantum mechanics**; **Solar**
ergy.

iotocomposition, also called *photoimagesetting,*
ny of several methods of assembling type and illus-
tions on photographic paper or film, or on a printing
te. It is used in the printing of books, newspapers,
sters, signs, and various other materials.

Photocomposition machines use computers to create
otographic images of type characters and of photos
d other illustrations, also called *graphics.* The material
be set is either typed on a keyboard, created with
mputer graphics software, or scanned electronically.
computer then stores this material as *digital* (numeric)
ormation in its memory, which also contains the in-
uctions for each character in a *font.* A font is a set of
the letters, numbers, and other characters of one
le of type.

The photocomposition machine uses the digital infor-
tion stored in the computer to reproduce the images
the type and illustrations as a pattern of dots. A laser
the machine sends out light pulses to form the im-
es on photosensitive paper or film, or directly on a
nting plate.

Photocomposition has many advantages over the old-
method of typesetting, which used metal type. It is
ch faster, and the use of computers simplifies many
erations. For example, computer programs can auto-
tically *justify* lines—that is, they can adjust the space
tween words, and hyphenate words when necessary,
line up the right-hand margin. In addition, changes in

Stream of light pulses
Stationary mirror
Photographic film
Laser
Spinning mirror
Laser positioning system
Film cassette

WORLD BOOK diagram by Linda Kinnaman

er photocomposition is a method of setting type and illus-
ions photographically. *Above,* a laser projects light pulses to
ate images of type characters. A laser positioning system uses
rors to direct the pulses onto film. The film is developed into
otographic positive, *below,* or a negative.

WORLD BOOK photo

218 Coffee bean

a line or page of text can be made on a computer with-
out rekeying the entire line or page. Frank J. Romano

See also **Printing** (Typesetting); **Type.**

Photoconductive cell. See **Electric eye.**

Photocopying. See **Copying machine.**

Photoelectric cell. See **Electric eye.**

Photoelectric effect. See **Einstein, Albert** (Famous theories); **Light** (Photoelectric and photoconductive effects; illustration).

Photoengraving and photolithography are processes that use photographic film positives or negatives to make printing plates and cylinders. Photoengraving and photolithography were the leading plate-making processes from the early 1900's until the 1980's. Today, most printers have computerized systems that store *digital* (numeric) files of text and illustrations, and they use lasers to produce images on printing plates or cylinders. Even most printers who still use photoengraving and photolithography use digital files to prepare the film used in the processes.

Photoengraving is a process used to prepare plates for relief printing or plates or cylinders for gravure printing. On plates used for relief printing, the image to be printed is raised above the nonprinting areas. On gravure plates and cylinders, the image consists of shallow depressions in the nonprinting areas. Photolithography is a process used to prepare offset lithographic plates. On offset plates, the image to be printed is level with the areas that do not print. For a discussion of the three printing methods, see **Printing.**

Capturing the image. Most printers use electronic scanners to capture images. A *flat bed scanner* scans *copy* (material to be printed) through a plate of glass on which the copy is laid flat. A *drum scanner* scans copy that has been mounted on a rotating drum. Both types use a light-sensing system that measures reflected light. Devices within the scanner convert the measurements to a digital code. This code is saved as a computer file that can later be used to guide a laser that exposes a sheet of film. To create the range of tones found in a photograph, a scanner converts the image to a *halftone.* A halftone uses dots of varying sizes or spacing to represent the tones in the original.

Scanners can separate color components for color printing. A printing plate prints with only a single color of ink. Printing in color usually requires four plates. Images for color printing are most often separated into





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Photoengraving and photolithography convert photographs into *halftones.* An enlargement of a halftone shows that dots of various sizes represent the range of tones in the original.



An offset lithography plat emerges from a plate proce sor. This machine has transferred to the plate's surface image of material that is to b printed. The plate, a flexible sheet of metal, will be wrapped around a printing press cylinder. During printing, both water and ink contact the plate. The image are repel water and attract ink. The nonimage areas accept water and repel ink.

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the four colors used to produce a full-color effect in printing. These colors are yellow, *magenta* (a purplish red), *cyan* (a blue), and black. The scanner is programmed to produce the yellow, magenta, and cyan components. A computer uses the color information to compute the black component.

In traditional photoengraving and photolithography, images are put on film photographically. To produce film of a single-color image, a photographer exposes one piece of film. For full-color plates, the photographer makes four exposures—one through each of four color filters—to produce the four color components.

Once film is exposed, whether by scanning or photography, it is developed into a negative. In the negative, the tones are the opposite of those in the original copy.

Transferring the image. Printers use negatives to transfer images to plates used for relief printing and to *negative-working offset plates. Positive-working offset plates* require film or paper positives, which are made by photographing negatives or by printing the negatives on film or light-sensitive paper. Techniques for transfe ring images to gravure plates and cylinders also use fil positives.

The printer fastens the negatives or positives to a sheet of plastic or special paper, creating a *flat.* A devi called a *vacuum printing frame* is used to create an air tight contact between the plate and the flat. In most ca es, light from powerful lamps passes through the trans parent parts of the film, exposing a light-sensitive coating on the plate. What happens next depends upo the type of plate.

Offset plates. There are two main types of offset plates: (1) surface plates and (2) bimetal plates. Both typ can be either negative-working or positive-working. S face plates are used most often. They generally consist of a thin sheet of aluminum covered with a light- or heat-sensitive coating. Aluminum attracts water but re pels ink. The coating repels water but attracts ink. A ne ative-working surface plate has a coating that hardens when exposed to light. A positive-working plate has a



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An electronic scanner records patterns of light reflected from pictures mounted on a rotating drum. The scanner produces a film image that is transferred to a printing plate.



United Engravers

A flexographic plate is peeled from a mold. This flexible rub ber plate, which carries the reverse of the image in the mold, will be wrapped around a cylinder on a printing press.

ating that softens when exposed to light or heat. After
ing exposed, the plates are washed in a solution that
moves the unhardened areas of the coating.
Bimetal plates consist of two metals, one on top of the
her. One metal is copper, which has an attraction for
k. The second metal can be chromium, aluminum, or
me other metal with an attraction for water. Bimetal
ates have a coating that hardens when exposed to
ht. After being exposed and washed, the plates are
hed using special chemicals that eat away the uncoat-
areas, revealing the bottom metal layer. Then the lith-
rapher scrubs away the hardened coating.

Plates for relief printing may be metal, rubber, or
stic. Printing with rubber or plastic plates is known as
xography. Metal plates generally are made of zinc,
pper, or magnesium and are coated with a light-sensi-
e substance. They are rarely used for printing. Instead,
ey serve as originals for the production of rubber
ates. After a metal plate is exposed and washed, the
otoengraver places it face down in a machine that
thes one side in acid. The acid etches away the back-
ound of the plate. A plastic mold is then made from
e metal original. A rubber sheet is heated and pressed
o the mold, and is cured to form a plate. Rubber
ates wrap around cylinders on a printing press.
Plastic plates are made of a layer of a *photopolymer,* a
ht-sensitive material that hardens when exposed to
ht, mounted on a metal or plastic base. Plastic plates
e used directly for printing. Like rubber plates, they
ap around press cylinders.

Plates and cylinders for gravure printing. Gravure
esses print with flat copper plates or thick, copper-
ted cylinders. During printing, depressions in the
te, called *cells,* are filled with ink. A thin blade wipes
excess ink from the nonprinting surface. The press
shes paper against the cells, transferring ink to the
per. The cells vary in depth, in area, or in both depth
d area. The shallowest, smallest ones hold the least
, and so they print in the lightest tones.
Gravure plates are exposed through a negative.
avure cylinders are rarely prepared using photo-
aphic processes.

Nonprinting applications. Computer engineers use
otolithography in the manufacture of certain comput-
chips. A light-activated film called a *photoresist* is ap-
ed to a silicon crystal. A *mask,* a sort of stencil, is then
ced over the film. Ultraviolet light shines through the
sk and eats away the film in the areas not covered by
mask. The remaining silicon forms a pattern of cir-
t pathways. Electronics manufacturers also use a pho-
ithographic process to print some computer circuit
ards. Frank J. Romano

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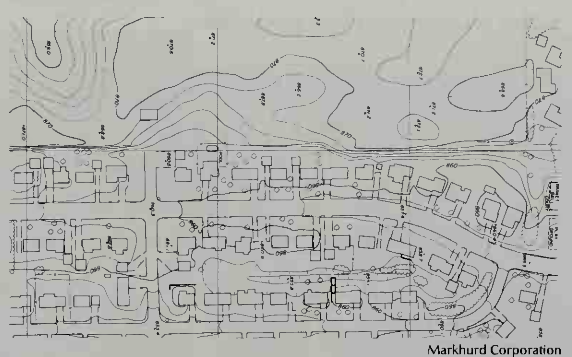
raving	Intaglio	Offset	Printing
hing	Lithography	Photography	

otogelatin. See **Printing** (Collotype printing).

otogrammetry, *FOH toh GRAM uh tree,* is the art
science of making surveys or maps with the help of
otographs. *Metrical photogrammetry* involves taking
asurements of photographic images to determine
tances, elevations, areas, and volumes. *Interpretative
otogrammetry* involves recognizing objects from
ir photographic images and judging their signifi-
ice. For example, in a forest damaged by disease,



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Markhurd Corporation

Photogrammetry is used to draw maps based on aerial photographs. A photogrammetrist uses a device called a *stereoplotter* to trace the contours from an aerial photograph like the one shown at the top. The contour map that results, *bottom,* shows features of the area in the correct position and proportions.

foresters can determine the extent of the damage to the
trees by examining aerial photographs of the area.

Photogrammetrists begin their work by obtaining
photographs of the area or objects to be measured. The
photographs may be taken on the ground or from an
aircraft or spacecraft. Photogrammetrists generally work
with ordinary photographs. But they also use pictures
produced by radar or other *remote sensors,* which
measure features using wavelengths outside the visible
range. *Infrared sensors,* which measure heat, are a type
of remote sensor. Most photographs used in mapmak-
ing are taken from an airplane by a special type of cam-
era. The camera takes photographs of overlapping sec-
tions of the area to be mapped.

To obtain accurate measurements from aerial or other
photographs, a photogrammetrist must correct any dis-
tortion in the pictures. In an aerial photograph, for exam-
ple, a hill appears larger than a valley of equal area.
Such distortion occurs because an airborne camera is
closer to hilltops than to valleys. Photogrammetrists cor-
rect such errors with a device called a *stereoplotter.* This
device uses photographs of an area taken from two lo-
cations to create a three-dimensional image.

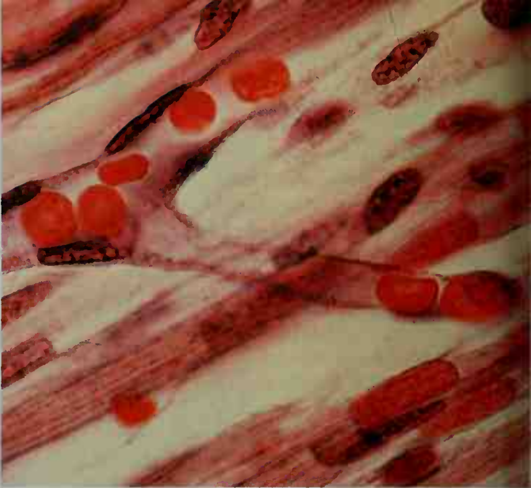
Photogrammetry started in 1840, when French physi-
cist and astronomer François Arago demonstrated the
use of photographs in surveying elevations and other
surface features of land. In 1859, Aimé Laussedat, a
colonel in the French Army, announced the first suc-
cessful use of photographs in surveying. Todd I. Blue

See also **Map; Surveying.**



Jet Propulsion Laboratory

Jupiter photographed from spacecraft



Lennart Nilsson from Behold Man. © 1974 Little, Brown and C

Red blood cells photographed through microscope



© Allsport

Sports action



© Brett Froomer, IBM Corporati

Magazine advertising

Photography is a universal means of communication and a valuable tool in many fields. From family snapshots to pictures taken from spacecraft, photographs record the people and things we see, as well as many subjects beyond our range of vision. Photography is also a major art form. In skillful hands, a camera can transform an ordinary scene into an image of exceptional beauty.

Photography

Photography is the process of making pictures by means of the action of light. Light reflected from an object forms a picture on a light-sensitive device or material. This picture is then chemically or digitally processed into a photograph. The word *photography* comes from Greek words meaning *to write or draw with light.* A photograph is basically a picture drawn with rays of light.

Nearly all photographs are made with cameras. A camera works in much the same way as the human eye. Like the eye, a camera takes in rays of light that are reflected from an object and focuses the rays into an image. But the camera records the image on film or on an electronic storage device, such as a floppy disk or mem ory card. As a result, the image not only can be made permanent but also can be seen by an unlimited number of people.

John Hedgecoe, the contributor of this article, is a professional photographer and the author of numerous books on photography.

Photography enriches our lives in many ways. From photographs, we can learn about people in other parts of the world. Photographs show us scenes from such historic events as the American Civil War (1861-1865) and the first landing on the moon by human beings. Photos also remind us of special people and important events in our own lives. Millions of people throughout the world take pictures of their family, friends, vacation and celebrations.

Special cameras can capture images in places where human beings cannot go—beyond the moon, to the bo tom of the ocean, and inside the human body. Pictures made on film sensitive to heat radiation help physician detect certain forms of cancer and other diseases.

Cameras can also "see" events in a way that the eye cannot. For example, some cameras can record action



Federal Bureau of Investigation

robbery recorded by hidden camera



Tom Caravaglia

Artistic multiple exposure of dancers



© Bob & Clara Calhoun, Bruce Coleman Inc.

speed photo of hummingbirds



Michael Dice

Family snapshot

occurs so rapidly we see it only as a blur. Through ype of photography, scientists examine moving of machinery and study hummingbirds in flight. ientific research is only one of the many fields in h photography plays an important role. In advertis- photographs are the most widely used means of cizing products and services. Photography is such sential part of news reporting that photojournalism ecome a specialized field. Mug shots and pictures with hidden cameras help the police track down nals. Military leaders use aerial photographs to about enemy troop movements and plan battle gy. Anthropologists and sociologists study photos rious groups of people for clues to patterns of hu- behavior.

me photographs, like great paintings, have lasting as works of art. Such pictures, through the pho- pher's imagination and technical skill, are excep- lly beautiful or express significant ideas.

rude type of camera was developed by about 1500. However, the first true photograph was not made until 1826. Early photographers needed much equipment and a knowledge of chemistry. Gradually, as a result of the scientific and technical discoveries of the 1800's and 1900's, cameras became more efficient and easier to operate. Today, a person can take a picture simply by aiming the camera and pressing a button. An instant camera can produce a photo in about 15 seconds. Digital cameras, which were introduced in the early 1990's, can produce an image almost instantly. These filmless cameras have a light-sensitive mechanism called a *charge-coupled device* (CCD). The lens focuses light on the CCD, which changes the light into electronic signals. The images can be viewed immediately on cameras equipped with a liquid crystal display (LCD) screen.

Photography can be divided into two general areas—*still photography* and *motion pictures*. This article discusses still photography. For information about motion pictures, see the *World Book* articles on Motion picture and Camcorder.

The photographic process

The process of making a photograph begins and ends with light. Rays of light enter a camera and are focused into an image. In traditional photography, light exposes the film in the camera, causing chemical changes on the film's surface. The exposed film is then treated with certain chemicals in a procedure called *developing.* Finally, light is used to make a print by transferring the image from the film to a sheet of special paper.

There are five principal steps in the traditional photographic process: (1) capturing light rays, (2) focusing the image, (3) exposing the film, (4) developing the film, and (5) making a print. This section describes the process of making a black-and-white photograph. The procedures used for making color photographs and instant prints are discussed in the *Developing and printing* section of this article. Pictures taken with a digital camera can be printed using a computer linked to a printer.

Capturing light rays. A camera is basically a box with a small *aperture* (opening) at one end and film at the other end. The inside of a camera must be completely dark so that rays of light reach the film only through the aperture. A device called a *shutter* opens when the camera is being used to take a picture. It remains closed at all other times to keep light away from the film.

In nearly all cameras, the aperture is part of a lens system. The lens system concentrates incoming rays of light on the film. In this way, the lens gathers enough light to expose the film in only a fraction of a second. Without a lens, the exposure might have to last as long as several minutes, and it would not form a sharp image.

When the shutter opens, light from an object passes through the aperture and forms an image of the object on the film. Rays of light from the top of the object go through the aperture and strike the lower part of the film. Light rays from the bottom of the object form the upper part of the image. Thus, the image on the film is upside down.

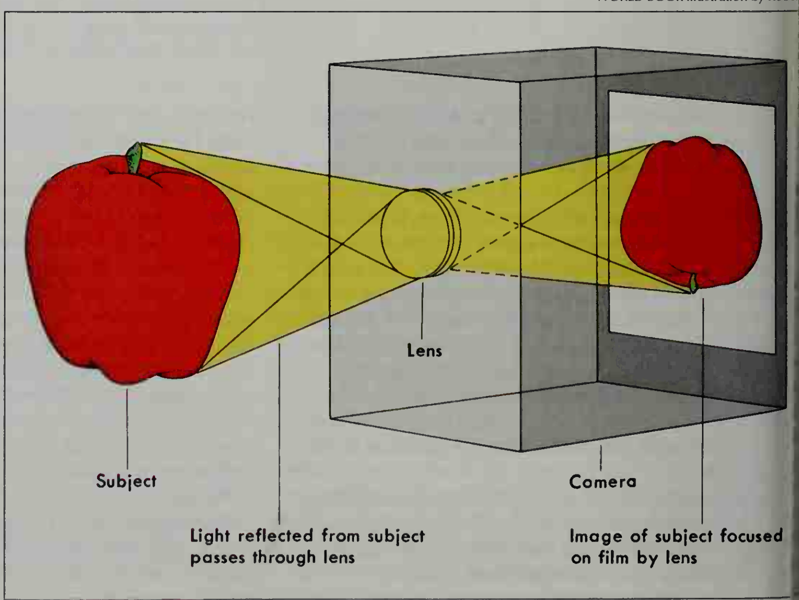
Focusing the image. In addition to concentrating t incoming rays of light, the camera lens serves to focus them on the film. As the light rays pass through the aperture into the camera, the lens bends them so that they form a sharp image. The sharpness of the image depends on the distance between the object and the lens, and between the lens and the film. Many camera have a focusing mechanism that moves the lens forwa and backward. In other cameras, the lens is fixed. Sucl cameras automatically focus on objects at a certain di tance from the lens. See **Lens.**

Exposing the film. Black-and-white film is a thin sheet of paper or plastic with a coating called an *emu sion.* The emulsion consists of tiny grains of silver salt held together by *gelatin,* a jellylike substance. Silver s are highly sensitive to light and undergo chemical changes when exposed to it. The degree of change in the salts depends on the amount of light that reaches them. A large amount of light causes a greater change than does a small amount.

The light that reaches the film varies in intensity. Lig colored objects reflect much light, and dark colors re flect little or no light. Therefore, the silver salts on the film react differently to different colors. Light from a white or yellow object changes the salts greatly. Light from a gray or tan object changes them only slightly. Black objects do not reflect any light and thus have n effect on the salts. The chemical changes in the silver salts produce a *latent image* on the film. This image c not be seen, but it contains all the details that will appear in the photograph.

Developing the film. After the film has been exposed, it can be removed from the camera. However must then be kept away from light because further ex posure would destroy the latent image. The film is tal to a darkroom or a photographic laboratory. There, it treated with chemical developers that convert the silv

WORLD BOOK illustration by Rober



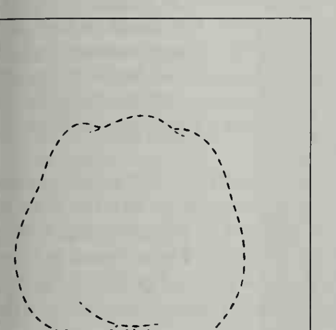
How an image is formed inside a camera

A camera is basically a box with a lens at one end and film at the other. Light reflected from a subject enters the camera through the lens, which focuses the rays of light into an image on the film. Light rays from the top of the subject make up the lower part of the image, and those from the bottom form the upper part. Thus, the image on the film is upside down.

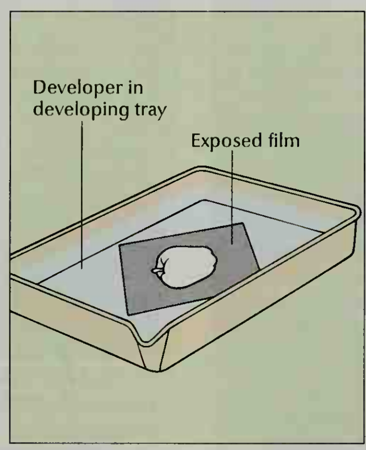
w a black-and-white photograph is developed and printed

en light enters a camera, it causes chemical changes on the surface of the film. These changes duce an invisible *latent image* of the subject. The latent image becomes visible after the film has n developed. During printing, this image is transferred onto printing paper.

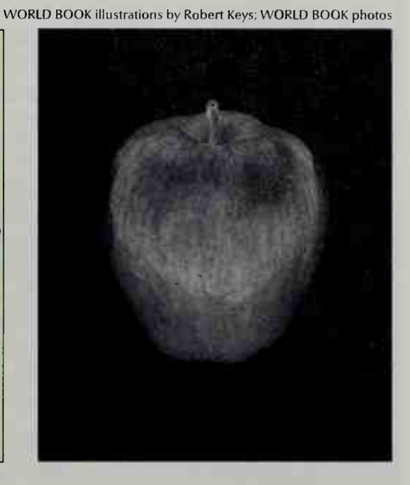
WORLD BOOK illustrations by Robert Keys; WORLD BOOK photos



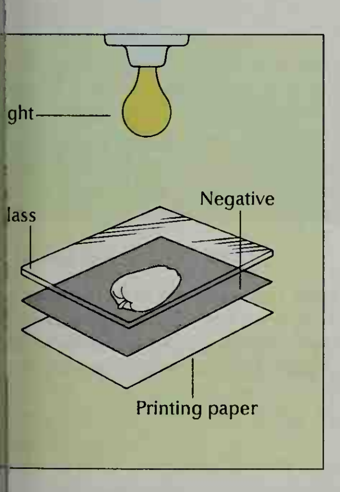
tent image forms after the film is ex- ed to light. It contains all the details will appear in the photo.



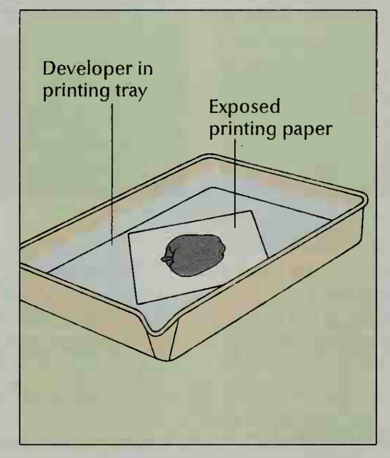
A developer converts the exposed silver salts on the film's surface into metallic silver, forming a visible image.



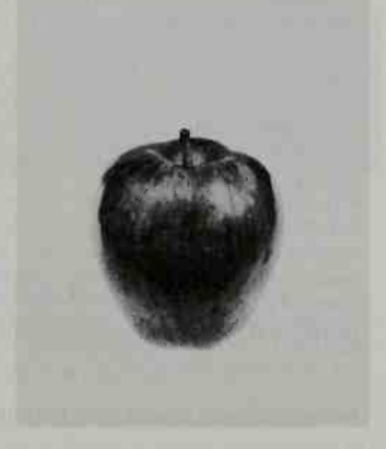
The developed film, which is called a *negative,* shows the subject's light and dark tones in reverse.



t passing through the negative ex- s the printing paper and forms a la- mage on the paper's surface.



The exposed printing paper is treated with a developer to produce a visible image known as a *positive.*



The print, or *positive,* reproduces the original colors of the subject in various tones of black, gray, and white.

on the emulsion into metallic silver. The image on ilm then becomes visible.

uring development, the silver salts that received h light form a thick deposit of silver and appear on the film. The salts that received little or no light a thin metallic layer or no layer at all. They appear or clear on the film. Thus, the light colors and dark rs of the subjects photographed are reversed on ilm. For example, a piece of coal would appear e on the film, and a snowball would look black. The loped film is called a *negative.* Before further pro- ng, negatives are treated with a chemical solution makes the image on the film permanent.

Making a print is similar to exposing and developing film. Like film, printing paper is coated with a light-sensitive emulsion. Light passes through the negative and exposes the paper, forming a latent image. After development and chemical treatment, the image on the printing paper is visible and permanent.

During exposure, the dark areas of the negative hold back much light. These dark areas show up as light areas on the print. The light and clear areas of the negative let a large amount of light pass through to the printing paper. They appear as dark areas on the print. Thus, the tones of the print reproduce those of the objects photographed.

Nearly anyone can take an ordinary photograph. All you need is a camera, film, light, and a subject. First, you look through the *viewfinder* of the camera to make sure that all of the subject will appear in the picture. Next, you press the *shutter release button* to allow light from the subject to enter the camera and expose the film. Then you use the *film advance,* which moves the film forward through the camera to put unexposed film in position for the next picture.

To take a truly good photograph, you must follow certain principles of photography. You should try to "see" as the camera does—that is, be aware of the elements that compose a picture. You also should know the effects of different types of light on film. Many cameras have controls that adjust the focus of the image and the amount of incoming light. In using such adjustable cameras, you need to know how the lens works and how exposure can be controlled. These aspects of good photography can be grouped as (1) composition, (2) light, (3) focusing, and (4) exposure.

Composition

Composition is the arrangement of elements in a photograph. The elements of composition include line, shape, space, and tone or color. Some guidelines for the use of the various elements may help you create the kind of photograph desired.

Line. There are two principal kinds of lines in photography, *real lines* and *implied lines.* Real lines are physically visible. For example, telephone poles and the edges of buildings form real lines. Real lines help to define space and create *perspective,* the illusion of depth and distance. Implied lines are created by nonphysical factors, such as a person's pointing gesture or gaze.

Both real lines and implied lines can be used to direct a viewer's eye to various parts of a picture. In most effective photographs, the lines draw attention to the main subject. The direction of these lines can also be used to reinforce the mood of a picture. Vertical lines, such as those of a tower or a tall tree, may convey a sense of dignity and grandeur. Horizontal lines tend to suggest peace and stillness, and diagonal ones may emphasiz energy and tension.

Shape is the chief structural element in the compo tion of most photographs. It enables the viewer to im mediately recognize the objects in a picture. Shape al adds interest to composition. The shape of such obje as rocks and seashells is interesting in itself. A combi tion of different shapes provides variety. For example outdoor scene can be made more interesting by contrasting the jagged shape of a fence with the soft cur of hills and clouds.

Space is the area between and surrounding the ob jects in a photograph. Space can be used to draw atte tion to the main subject and to isolate details in the pi ture. However, large amounts of space tend to detrac from a picture's interest. A general principle for the u of space is that it should not occupy more than a thir the photo.

Tone or color adds depth to the composition of a photograph. Without this element, the shapes and spaces in a picture would appear flat. In black-and-wl photography, the colors of objects are translated into tones of black, gray, and white. These tones help esta lish the mood of a picture. If light tones dominate the photo, the mood may seem happy and playful. A pict with many dark tones may convey a sense of sadness mystery.

Color, like tone, carries an emotional message. In a color photograph, such bright colors as red and orar create an impression of action and energy. Blue, gre and other softer colors are more restful to the eye an may suggest a feeling of peace. According to many p fessional photographers, a color picture should have one dominant color and a balance between bright c ors and softer shades.

Light

There are two basic types of light in photography, ural light and *artificial light.* Natural light, which is als called *available light* or *existing light,* is normally pre in outdoor and indoor locations. Such light comes

Some common mistakes in taking pictures



Cropped heads result from framing the subject improperly in the viewfinder.



A tilted view of the subject appears if the camera is not held in a level position.



A blurred image is produced by moving the camera while taking a picture.



WORLD BOOK

An out-of-focus shot is caused by poor focusing standing too near the sul

ow lines can be ed in a photo

e lines in a photograph can used to direct a viewer's to the center of interest. ey also can reinforce the od of a scene. Vertical es may express feelings of nity and grandeur. Horintal lines often convey a ise of balance and quiet tfulness. Diagonal lines can ggest energy and possible vement.



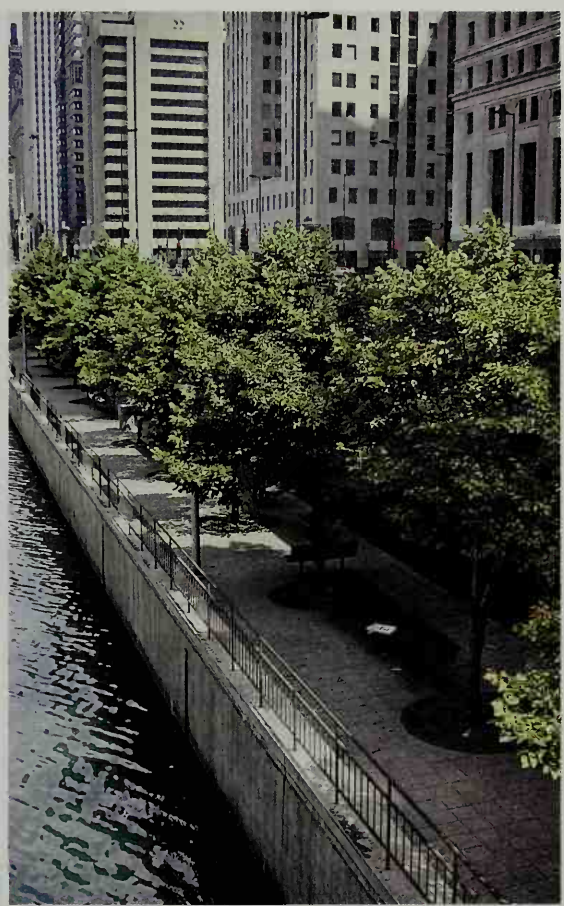
WORLD BOOK photo by Steven Spicer

Vertical lines



© Karen A. McCormack

rizontal lines



© Karen A. McCormack

Diagonal lines

efly from the sun and electric lights. Artificial light is oduced by various types of lighting equipment, such photoflood lamps and electronic flash devices. Lighting equipment is discussed in the *Photographic equipnt* section.

Natural light and artificial light have certain charactercs that greatly affect the quality of photographs. ese characteristics include (1) intensity, (2) color, and direction.

ntensity is the quantity or brightness of light. Phoraphers measure the intensity of light to determine *lighting ratio* of a scene. The lighting ratio is the difence in intensity between the areas that receive the st light and those that receive the least. On a sunny or in a room with bright lights, the lighting ratio may high. On a cloudy day or in dim indoor light, the ratio robably low.

The lighting ratio affects the degree of contrast in a otograph. A high lighting ratio may produce sharp ages with deep shadows and bright highlights. A low o creates softer images with a wide range of medium es. Thus, a high lighting ratio can create a sense of ma and tension in a picture. A low lighting ratio makes portraits and still-lifes look more natural.

Most lighting ratios can be used with black-and-white film. In taking color photographs, however, a high lighting ratio may make some colors appear either faint or excessively dark.

Color. The color of light varies according to its source, though most of these variations are invisible to the human eye. For example, ordinary light bulbs produce reddish light, and fluorescent light is basically blue-green. The color of sunlight changes during the day. It tends to be blue in the morning, white at about noon, and pink just before sunset.

Variations in the color of light make little difference in a black-and-white photograph. In color pictures, however, they produce a wide variety of effects. To control these effects, you can use color filters on your camera, or you can use color film that is designed for different types of indoor and outdoor lighting. Such accessories are discussed in the *Photographic equipment* section of this article.

Direction refers to the direction from which light strikes a subject. Light may reach a subject from the front, the back, the side, or the top. Light may also strike

Outdoor lighting

The sun is the main source of light in most photos taken outdoors. When the subject faces the sun, sunlight illuminates the face clearly but may cause the person to squint. Sunlight shining on one side of the subject casts shadows on the other side. These shadows can be filled in with light from an electronic flash device or some other source.



Sunlight from front



Sunlight from side



Flash fill-in

WORLD BOOK pl

a subject from several directions at once. The direction greatly affects how the subject looks in the picture.

Front lighting comes from a source near or behind the camera. This type of lighting shows surface details clearly. However, it should be avoided for pictures of people because the light makes them squint and casts harsh shadows under their features.

Back lighting comes from a source behind the subject. Light from this direction casts a shadow across the front of the subject. To fill in the shadow, additional light from an electronic flash can be used. This technique is called *flash fill-in.* If the back lighting is extremely bright, the picture may show only the outline of the subject. Back lighting can be deliberately used in this way to create silhouettes.

Side lighting shines on one side of the subject. Shadows fall on the side opposite the source of the light. Flash fill-in can be used to lighten these shadowed areas. Side lighting does not show surface detail as clea as front lighting does, but it creates a strong impressi of depth and shape.

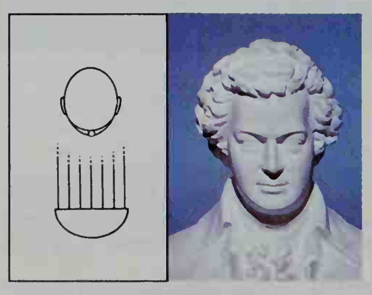
Top lighting comes from a source directly above th subject. It is used most frequently in situations where other types of lighting would cause a glare or reflecti in a picture. For example, top lighting may be used to photograph fish in an aquarium or objects in a displa case or behind a window because the light will not b reflected by the glass.

Focusing

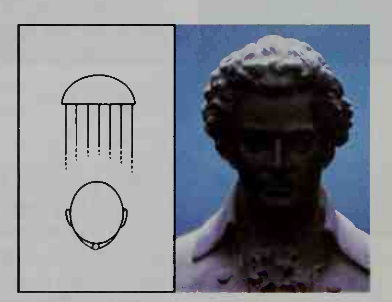
Focusing controls the sharpness of the image in a photograph. The degree of sharpness is determined b (1) the distance between the camera lens and the subj and (2) the distance between the lens and the film insi

Indoor lighting

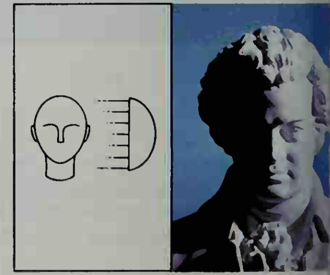
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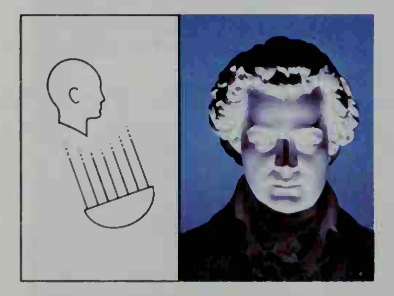
Front lighting comes from a source near the camera. It highlights the subject's face, reducing some surface detail.



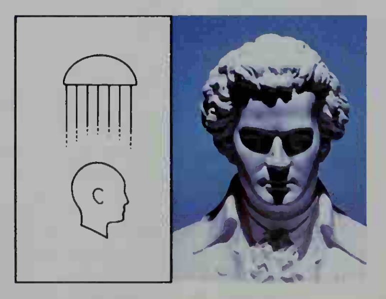
Back lighting comes from a source behind the subject. It throws a shadow over the entire front of the subject.



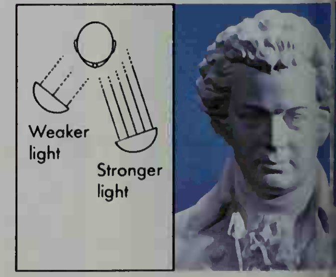
Side lighting shines on one side of th subject. It casts shadows on the side o posite the source of light.



Bottom lighting comes from below the subject. It produces harsh highlights that distort the subject's appearance.



Top lighting comes from directly above the subject. It creates an extreme contrast between light and shadow.



Multiple lighting can be used to ligh the shadows produced by individual sources of light.

ing shutter speed "stop" action

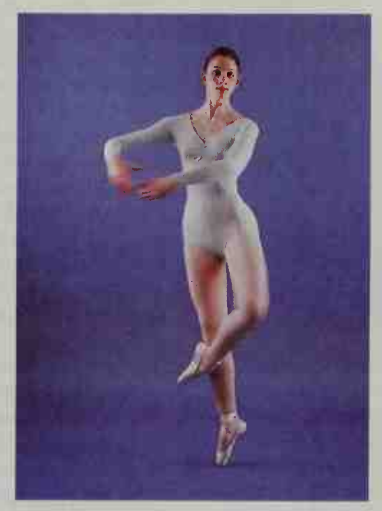
Shutter speed is the amount of time the shutter remains open during exposure. At the slow shutter speeds of 1 second or $\frac{1}{60}$ of a second, all or part of a moving dancer looks blurred. At a fast setting, such as $\frac{1}{500}$ of a second, the shutter is open so briefly that the dancer's movement appears "stopped."



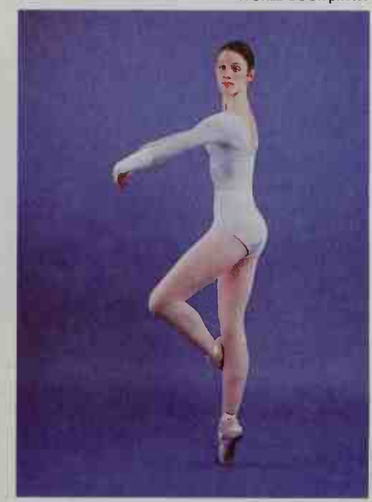
WORLD BOOK photos



ıtter at 1 second



Shutter at $\frac{1}{60}$ second



Shutter at $\frac{1}{500}$ second

camera. To form a sharp image of a subject that is se to the camera, the lens must be relatively far from film. For subjects far from the camera, the lens must close to the film. See **Lens**.

n nonadjustable cameras—that is, cameras without a ntrol to adjust the focus—focusing depends on taking tures at a certain distance from the subject. Most h cameras are designed to focus on subjects more n 6 feet (1.8 meters) away. If the subject is closer than et, the picture will be blurred.

Adjustable cameras have a focusing mechanism that anges the distance between the lens and the film. ıny of these cameras contain a built-in *viewing screen* t provides an image of the subject while the photog- her focuses. Various devices on the viewing screen licate the proper focus. In some cameras, the viewing een shows two identical images or one image split ɔ two halves. To focus, the photographer turns the fo- ;ing control until the double image becomes one ırp image or until the two halves come together. In ıer cameras, tiny dots appear on the screen until the ıge has been focused.

Exposure

Exposure is the total amount of light that reaches the ı in a camera. Exposure affects the quality of a photo- .ph more than any other factor. If too much light en- s the camera, the film will be *overexposed,* and the ture will be too bright. If there is insufficient light, the ı will be *underexposed,* resulting in a dark, uninter- ing picture.

n nonadjustable cameras, the exposure is set auto- tically. Most adjustable cameras have controls that ulate the incoming light. To set the exposure on such ımera, the photographer adjusts the settings on se controls.

Controlling exposure. Adjustable cameras have two controls that regulate exposure. One of these controls changes the speed of the shutter, and the other changes the size of the aperture.

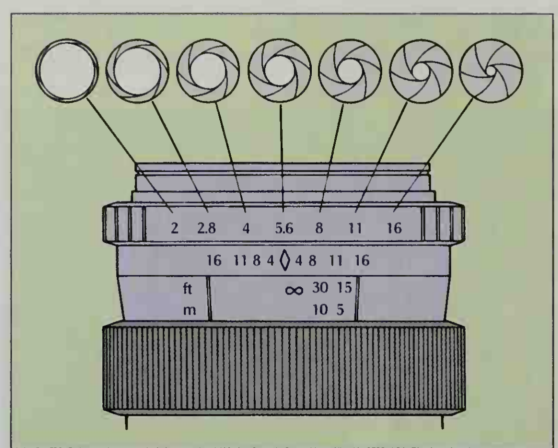
Shutter speed is the amount of time the shutter remains open to let light expose the film. A slow shutter speed lets in a large amount of light, and a fast shutter speed admits only a little.

Many adjustable cameras have a range of shutter speeds that vary from 1 second or longer to $\frac{1}{1,000}$ of a second or faster. These speeds are represented by whole numbers on the standard scale of shutter speeds. The number 500 on the scale stands for $\frac{1}{500}$ of a second, 250 means $\frac{1}{250}$ of a second, and so on. Each number on the scale represents twice the speed of the preceding number or half the speed of the next number. At a setting of 250, for example, the shutter works twice as fast as at a setting of 125 and half as fast as at a setting of 500.

Fast shutter speeds enable photographers to take sharp pictures of moving subjects. Any movement of the subject while the shutter remains open will be recorded as a blur. At a setting of $\frac{1}{1,000}$ of a second or faster, the shutter is open for such a short time that even the motion of a speeding race car appears to be "stopped."

Aperture size is changed by a device called a *diaphragm,* which consists of a circle of overlapping leaves. The diaphragm expands to make the aperture larger and contracts to make it smaller. A large aperture admits more light than a small one.

The various sizes of an aperture are called *f-stops* or *f-numbers.* On most adjustable cameras, the f-stops range from 1.4 or 1.8 to 22 or 32 and include 2, 2.8, 4, 5.6, 8, 11, and 16. The smaller the number, the larger the size of the aperture. Like the shutter speeds, each f-stop lets in either twice as much light as the preceding setting or half as much light as the next higher setting. For exam-



WORLD BOOK illustration by Robert Keys

Aperture size is measured in *f-stops,* which range above from 2 to 16. These numbers appear on the aperture-setting ring of most cameras. The higher the f-stop, the smaller the aperture.

ple, if you *open up* the setting from f/11 to f/8, the aperture admits twice as much light into the camera. If you *stop down* the setting from f/11 to f/16, the aperture lets half as much light into the camera.

Changes in the size of the aperture affect the overall sharpness of the picture. As the aperture becomes smaller, the area of sharpness in front of and behind the subject becomes larger. This area of sharpness is called *depth of field.* It extends from the nearest part of the subject area in focus to the farthest part in focus. A small aperture, such as f/11 or f/16, creates great depth of field. As you open up the aperture, the area in focus becomes shallower. At f/4 or f/2, the subject will be in focus, but objects in the foreground and background may be blurred.

Setting the exposure. The proper exposure for a picture depends chiefly on (1) the lighting, (2) the subject, and (3) the desired depth of field. Each of these factors may require an adjustment in shutter speed or aperture size. You must choose a combination of settings that will meet all the requirements.

The amount of light in a scene affects both shutter speed and aperture size. On a cloudy day, you shoulc reduce the shutter speed and increase the f-stop. On sunny day, you should use settings for a fast shutter a a small aperture. Certain types of artificial lighting hav special requirements for exposure.

The type of subject to be photographed may requi an adjustment in the shutter speed, and depth of fielc may determine the aperture size. If the subject is mov ing, you must increase the shutter speed to prevent blurring. If you want a large area of the picture to be i sharp focus, you should choose a small aperture to p vide greater depth of field.

If you adjust either the shutter speed or the apertu size, you must also adjust the other. A fast shutter spe stops the action, but it also reduces the amount of lig reaching the film. To make up for this reduction in lig you should increase the f-stop. Similarly, a small aper ture increases depth of field but reduces the amount incoming light. Therefore, you should change to a slc er shutter speed.

Suppose you want to photograph some squirrels o sunny day. A suitable exposure might be a shutter sp of $\frac{1}{60}$ and an aperture of f/11. If the squirrels are movi you might increase the shutter speed to $\frac{1}{125}$. This spee is twice as fast as $\frac{1}{60}$ and so half as much light will rea the film. You should make the aperture twice as large setting it at f/8.

You may want the photograph to include some acorns on the ground in front of the squirrels, and al the trees in the background. You can increase depth field by reducing the size of the aperture. At a setting f/16, the film will receive half as much light as it did a f/11. You should also change the shutter to the next slowest speed, so that the film will be exposed for tw as long. At a slow shutter speed, however, blurring fr movement of the squirrels or the camera may occur. better option in this situation might be to retain the faster shutter speed and use a faster speed of film. Fo information on film speed, see the *Film* section of thi article.

Controlling depth of field

Depth of field is the area of sharpness in front of and behind the subject of a photo. The size of this area can be controlled by adjusting the aperture setting on a camera. A wide aperture produces shallow depth of field, and a small one creates great depth of field.



At f/2, depth of field extends only a short distance from a subject in focus. If the objects in front are sharp, those in back are blurred.



WORLD BOOK photos by Steven

At f/16, depth of field is large. All objects a focus. The chair and wall appear as sharp a the cup and other objects in the foregroun

ıere are five main types of photographic equipment. ıey are (1) cameras, (2) film, (3) lighting equipment, filters, and (5) tripods.

Cameras

Nearly all cameras have the same basic design, which cludes an aperture, a shutter, a viewfinder, and a film vance. However, cameras vary widely in such features adjustability and the type of film used.

The simplest cameras, called *fixed-focus cameras,* ve a nonadjustable lens and only one or two shutter eeds. Most of these cameras use 35-millimeter or adnced photo system (APS) film. APS film has a width of millimeters. A cassette of APS film is smaller and hter in weight than a 35-millimeter film cassette. APS meras are, in general, smaller and lighter than 35-milneter cameras.

Professional cameras, including *view cameras* and *udio cameras,* have many adjustable parts. Most such meras use large sheets of film. *Digital cameras* do not e film. Instead, they store images as electronic inforation that can be used on a computer. For more inforation on view cameras, studio cameras, and digital meras, see **Camera.**

One common classification for cameras is based on e viewing system. The principal types of cameras sed on viewing systems are (1) direct vision, (2) singlens reflex, and (3) twin-lens reflex.

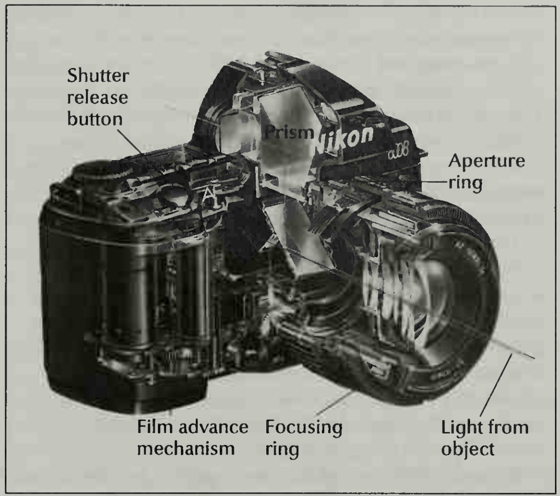
Direct vision cameras have a viewing system that is parate from the lens. The category includes *range der* and *point and shoot* cameras. Many direct vision meras are lightweight and relatively inexpensive. ost use 35-millimeter film.

On most direct vision cameras, the viewfinder is a nall window near the lens. On a range finder camera, angled mirror behind the lens reflects a second ime of the subject into the viewfinder. To focus, a pern looks through the viewfinder and adjusts the focus- mechanism until the two images come together. The cused image in the viewfinder differs slightly from the age on the film. This difference is called *parallax error.* help correct for parallax error, the viewfinder has es that frame the subject area "seen" by the lens.

Point and shoot cameras include electronic devices at automatically adjust the focus and set the light expore. Some point and shoot cameras use APS film.

Single-lens reflex cameras enable a photographer look at a subject directly through the lens. A mirror echanism between the lens and the film reflects the age onto a viewing screen. When the shutter release tton is pressed, the mirror rises out of the way so that light exposes the film. Thus, the photographer sees image almost exactly as it is recorded on the film, d parallax error is avoided.

Single-lens reflex cameras are heavier and more exnsive than most direct vision models. Most use 35llimeter film. Others use APS film. Single-lens reflex meras can utilize a variety of interchangeable lenses. eir standard lens can be replaced by lenses that ange the size and depth relationships of objects in a ene. Such lenses include *wide-angle lenses, telephoto ses, macro lenses,* and *zoom lenses.*



Nikon, Inc.

A single-lens reflex camera, or *SLR camera,* lets a photographer view subjects directly through the lens. Most SLR models have controls for focusing, aperture size, and shutter speed.

A wide-angle lens provides a wider view of a scene than a standard lens does. It is used for large scenes and in locations where the photographer cannot move back far enough to photograph the entire scene. A telephoto lens makes objects appear larger and closer. It enables photographers to take detailed pictures of distant subjects. A macro lens, which is used in extreme close-up photography, focuses on subjects from a short distance. A zoom lens combines many features of standard, wide-angle, and telephoto lenses.

Twin-lens reflex cameras have their viewing lens directly above the picture-taking lens. The image in the viewing lens is reflected onto a screen at the top of the camera. A person holds the camera at waist- or chest-level and looks down at the viewing screen.

The viewing screen of a twin-lens reflex camera is much larger and clearer than those of eye-level cameras. Most twin-lens reflex models use film that produces negatives measuring $2\frac{1}{4}$ by $2\frac{1}{4}$ inches (5.7 by 5.7 centimeters). However, these cameras are subject to parallax error and are heavier than the majority of single-lens reflex cameras. Also, most twin-lens reflex cameras do not have interchangeable lenses.

Film

A majority of the cameras used by amateur and professional photographers require 35-millimeter film. The image captured on this film has an *aspect ratio* of 2 to 3. The aspect ratio is a comparison of the horizontal or vertical length of the image to its other dimension. An APS camera captures images that can be printed using any of three different aspect ratios. In addition to the emulsion that captures the image, APS film includes a magnetic coating. At the time a picture is taken, the photographer stores information in this coating directing a film laboratory to produce the print in a specific aspect ratio. Prints can be made later using a different format. *Classic format* produces prints with the same ratio as those pro-

duced by 35-millimeter film; *H format,* or *HDTV format,* has an aspect ratio of 9 to 16; and *panoramic format* has an aspect ratio of 1 to 3. Some APS cameras enable the photographer to magnetically store such information as a title to be added to the photograph or the number of prints to be produced from each individual image.

APS film offers a greater number of exposures than 35-millimeter film. The 35-millimeter standard offers 12, 24, or 36 exposures per roll. APS film offers 15, 25, or 40.

There are three main kinds of photographic film, based on the type of pictures produced. Black-and-white prints are made from *black-and-white negative film,* color prints from *color negative film,* and color slides from *color reversal film.* Film of each type varies in a number of characteristics that affect the overall quality of photographs. The most important of these characteristics include (1) speed, (2) graininess, (3) color sensitivity, and (4) color balance.

Speed is the amount of time required for film to react to light. A film's speed determines how much exposure is needed to record an image of the subject. A fast film reacts quickly to light and needs little exposure. It is useful for scenes that have dim light or involve fast action. A medium-speed film requires moderate exposure and is suitable for average conditions of light and movement. A slow film needs much exposure and should be used for stationary subjects in a brightly lighted scene.

The principal systems of measuring film speed are the *DIN system,* used chiefly in Western Europe, and the international *ASA* and *ISO* systems. ASA stands for the American Standards Association, and ISO stands for the International Organization for Standardization. The higher the ASA or ISO number, the faster the film. Films that have numbers of 200 or higher are generally considered fast. Medium-speed films have numbers ranging from 80 to 125, and slow films are numbered lower than 80.

Graininess is the speckled or hazy appearance of some photographs. It is caused by clumps of silver grains on the film. The degree of graininess depends on the speed of the film. A fast film is more sensitive to light than other films are because its emulsion contains larger grains of silver salts. The fastest films produce the grainiest pictures. Medium-speed films and slow films produce little or no graininess in standard-sized prints though some graininess may appear in enlargements.

Color sensitivity refers to a black-and-white film's ability to record differences in color. On the basis of c or sensitivity, black-and-white films are classified into several types, including *panchromatic film* and *orthochromatic film.* Panchromatic film, the most widely use type, is sensitive to all visible colors. Orthochromatic film records all colors except red. It is used chiefly by commercial artists to copy designs that have few color

Color balance applies only to color film. Such film i sensitive to all colors, including those of different kind of light. The human eye sees light from most sources a white. But color film records light from light bulbs as reddish, light from fluorescent bulbs as blue-green, an daylight as slightly blue. Variations in the emulsions of different types of color film make the film less sensitive to certain colors. These variations balance the color of light recorded on the film so colors in the photograph appear natural. Most color film is balanced either for daylight or for specific types of artificial light.

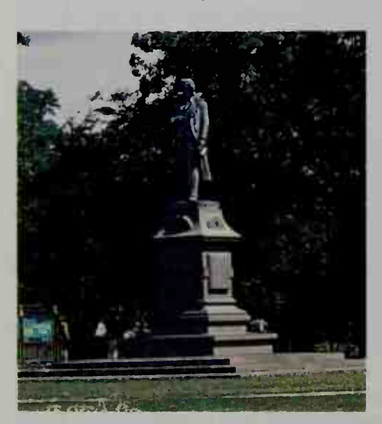
Lighting equipment

Lighting equipment can be divided into two basic ca egories according to function. *Exposure meters,* the fir category, measure the light available for photography. *Artificial lighting devices,* the second category, provid any additional light needed to take a picture.

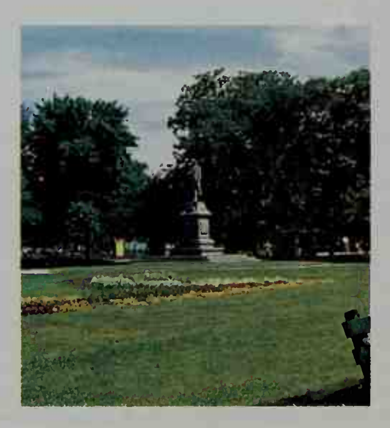
Exposure meters, also called *light meters,* help determine the correct exposure. Exposure meters are hel in the hand or are built into a camera. Handheld meter record the light in a scene and indicate the camera settings for the proper exposure. Built-in meters measure the light that strikes the lens of the camera. Light readings appear on a scale on the viewing screen. Some cameras with exposure meters automatically adjust th shutter speed and aperture size to the amount of light

Some types of camera lenses The standard lens on many cameras can be replaced by specialized lenses, such as a *wide-angle lens* or a *telephoto lens.* A wide-angle lens provides a wider view of a scene but makes objects appear smaller and farther away. A telephoto lens makes the subject seem larger and closer.

WORLD BOOK photos by Steven Sp



View with standard lens



View with wide-angle lens



View with telephoto lens



WORLD BOOK photo by Steinkamp/Ballogg

ectronic flash units can be attached to a camera or held sepa-ely. They contain ionized gas in a glass tube. Electric current ıkes the gas glow. These units can be used repeatedly.

ailable. Exposure meters are classified according to e way they measure light. They include (1) reflected ıht meters and (2) incident light meters. Many hand-ld instruments can be used as both types of meters. ost built-in meters are reflected light meters.

Reflected light meters measure the light reflected om a scene toward the camera. Various areas in the ene reflect different amounts of light. Most built-in eters show the average amount of light reflected from the areas. To measure reflected light with a handheld eter, the meter should be aimed at the main part of e scene. If there are strong contrasts in light and shad-v, separate readings of the brightest and darkest areas ıould be taken and then averaged.

Incident light meters measure the light falling on a ıbject. When measuring this kind of light, the photog-pher should stand near the subject and point the me-r toward the spot where the photo will be taken.

Artificial lighting devices. The most widely used ıurce of artificial lighting is the electronic flash, which ovides a short burst of light. Many professional pho-graphers use *photoflood lamps*—lighting devices that ın provide continuous light for several hours.

Most cameras have a built-in device called a *flash syn-ıronizer.* A flash synchronizer coordinates the flash sys-m with the shutter, so that the greatest brightness of e flash occurs at the instant the shutter reaches its full oening. On many cameras, the flash synchronizer orks for electronic flash at a setting of *X.*

Electronic flash units operate on batteries or on elec-ic current from an outlet. They contain an *ionized* (electrically charged) gas inside a sealed tube. The gas emits a burst of bright light when an electric current is passed through it. Electronic flash units can fire thousands of flashes. Electronic flash equipment ranges from small flash units that fit onto the top of a camera to large studio units. Some flash devices are small enough to be built into cameras. Camera-top flash units are mounted onto a flat piece of metal called a *hot shoe.* The hot shoe contains electrical contacts for the flash unit so that it can be triggered by the flash synchronizer.

Filters

A photographic filter is a disk of colored, plasticlike gelatin or colored glass in a holder. The holder fits over the lens of specific types of cameras. Filters screen out haze and glare or increase the contrast among tones in a picture. Nearly all filters hold back some light from the film. Therefore, when using a filter on most cameras, you must increase the exposure by the *filter factor* listed in the instructions provided with the film.

The most widely used filters include *ultraviolet filters, polarizing filters,* and *color filters.* An ultraviolet filter reduces haze. It is useful for photographing distant subjects and for taking pictures at high altitudes. A polarizing filter makes colors more vivid and screens out glare from shiny surfaces, such as water and glass. A color filter increases contrast in black-and-white photographs. It lets light of its own color pass through the lens to the film but holds back certain other colors. As a result, objects that are the same color as the filter appear light in the picture, and the blocked colors are dark. Suppose you use a red filter when taking a black-and-white photograph of an apple tree. The apples will look light gray, and the leaves and the sky will be dark gray or black.

Tripods

Movement of a camera during a long exposure may blur the picture. If the exposure time is more than $\frac{1}{30}$ second, a photographer should use a camera support. The most common type of support is a three-legged device called a tripod.

The steadiest tripods are built for studio use or to support heavy cameras and lenses. These tripods may be too heavy to be carried around by a photographer doing field work. Lighter, more portable tripods with retractable legs are used by most serious photographers. On most tripods, three legs support a center column. The column can move up and down to adjust the height without adjusting the length of the tripod's legs. The camera is mounted on the tripod's *head,* at the top of the column. Handles and knobs on the head enable the photographer to change the angle of the camera shot by *panning* left and right and *tilting* up and down.

Developing and printing

After the picture has been taken, the latent image on e film cannot be seen. The image becomes visible rough the process of developing the film into a nega-/e. The negative shows the reverse of the subject's ght and dark areas. During printing, the image on the film is transferred onto paper, and the original colors or tones of the subject are restored.

Most amateur photographers have their film processed in commercial laboratories. Some photographers, however, choose to develop and print their own pic-

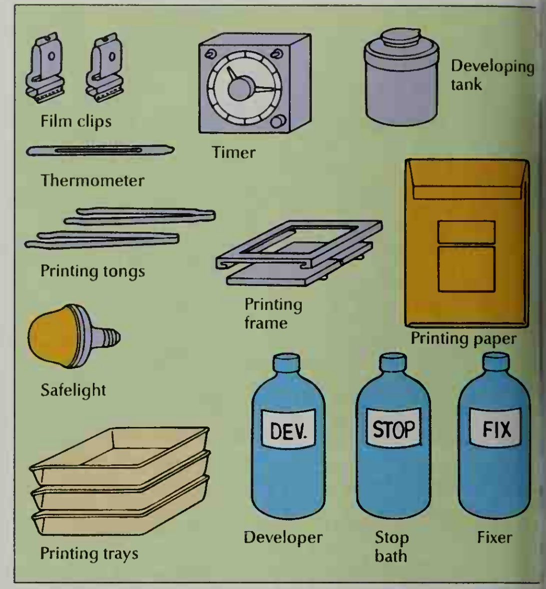
tures. By processing and printing the film themselves, they can change the size, composition, contrast, and other features of the photographs.

Black-and-white film and color film are developed and printed in much the same way. Most types of film are removed from the camera and processed in a darkroom or a photographic laboratory. Instant film contains all of the materials needed to create a positive print. It produces photographs directly from the camera.

It is more complicated and expensive to process color film than to process black-and-white film. The processing of color film requires extra steps and some additional materials. Many fewer amateur photographers develop color film than develop black-and-white film.

APS film is intended to be developed only in a film laboratory. The laboratory returns the negatives stored in the original film cassette. For a laboratory to produce prints as intended by the photographer, it must have equipment that can read the information stored on the film magnetically.

Developing black-and-white film requires two or more chemical solutions, several pieces of equipment, and running water. The chemical solutions should be stored in amber-colored bottles made of polyethylene plastic. Such bottles are highly resistant to chemicals and keep light from harming the solutions. Each bottle



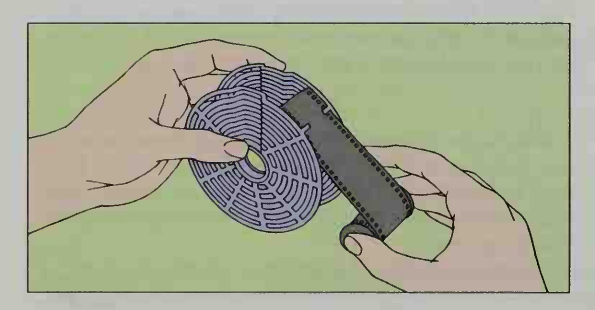
WORLD BOOK illustrations by Robert K

Equipment for developing and printing includes the items shown here. These processes also require completely dark surroundings and running water.

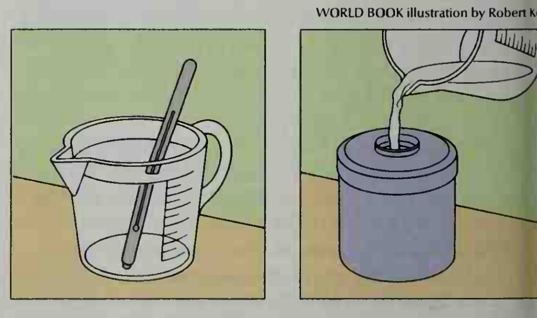
How to develop film

To develop film, you need three main chemical solutions. The *developer* converts the exposed silver salts on the film into metallic silver. The *stop bath* halts the action of the developer. The *fixer,* also called *hypo,* dissolves the unexposed silver salts so they can be washed away.

WORLD BOOK illustration by Robert Ke

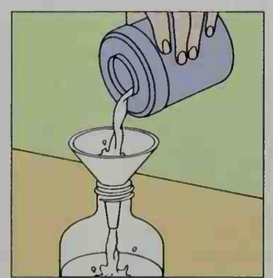


Wind the film onto the reel of the developing tank. Then place the reel in the tank and close the lid. You must work in total darkness until the film is inside the covered tank.

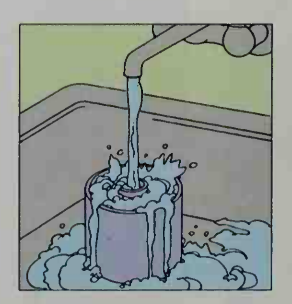


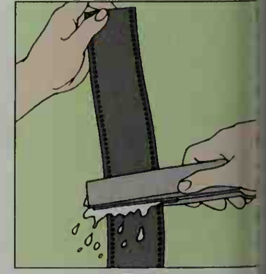
Measure the developer and bring it to the correct temperature, as specified in the instructions that come with the film. Next, pour the liquid into the tank and begin to time the proces





Agitate the tank at regular intervals during development. When the developing time is up, pour out the developer and add the stop bath. Then drain the tank and pour in the fixer.





Rinse the film with running water or a washing agent. Unwind the film from the reel of the tank and remove excess water with a squeegee. Finally, hang the film to dry in a dustfree area.

w to judge a negative

Negatives should have good contrast among tones, plus detail in both highlight and shadow areas. If a negative is mostly dark and lacks detail in the highlight areas, it may be *overexposed.* A negative that has harsh highlights and few details in the shadow areas is probably *underexposed.*

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rmal negative



Overexposed negative



Underexposed negative

ould be clearly labeled with the name of its contents. developed film must not be exposed to light, and so ompletely dark room or a lightproof *changing bag* also needed.

The developing process has five basic steps. First, a emical called a *developer* converts the exposed silver ts on the film's emulsion into metallic silver. The acn of the developer is then stopped either by water or a chemical solution known as a *stop bath.* In the third p, a chemical called a *fixer,* or *hypo,* dissolves the unosed silver salts so they can be washed away. The er also contains a special hardening agent that makes emulsion resistant to scratches. Next, the film is shed to remove the unexposed salts and the remain- chemicals. In the final step, the film is dried. The deloped film is now a negative on which a visible, pernent image has been recorded.

If you wish to process film yourself, first darken the om or use a changing bag and remove the film from spool. Then wind the film onto a reel that fits inside a htproof *developing tank.* This tank is designed so that uids can be poured into or out of it without removing lid. After the film is in the developing tank, you can rk on it in the light.

Different types of developers and fixers are used for rious kinds of film. The instructions provided with the n specify the type of solutions to use and the correct nperatures for the best results. Temperature is particrly important for the developer. Negatives will be erdeveloped if the developer is too warm, or underveloped if it is too cold. The instructions also tell you w long to treat the film with the various solutions. To sure proper development, each operation should be ned exactly.

After the developer has been heated or cooled to the rrect temperature, pour the chemical into the develing tank. Then *agitate* the tank for 30 seconds by reatedly turning it upside down and back again in a ady movement. Agitation keeps a fresh supply of the veloper in contact with the film so the image on the n's surface develops evenly. Next, rap the tank on a hard surface to dislodge any air bubbles. Air bubbles can leave spots on the film. While the developer is in the tank, the film should be agitated at half-minute or one-minute intervals after the first 30 seconds.

When the developer has been in the developing tank for the specified time, pour it out and fill the tank with either running water or a stop-bath solution. Agitate the tank vigorously for about 10 seconds, and then drain it and pour in the fixer. After the fixing bath, which may last from 2 to 10 minutes, rinse the film with water or a special washing agent. Such an agent reduces the washing time from about 20 minutes to about 5 minutes. The film should then be treated with a wetting agent to remove any water spots.

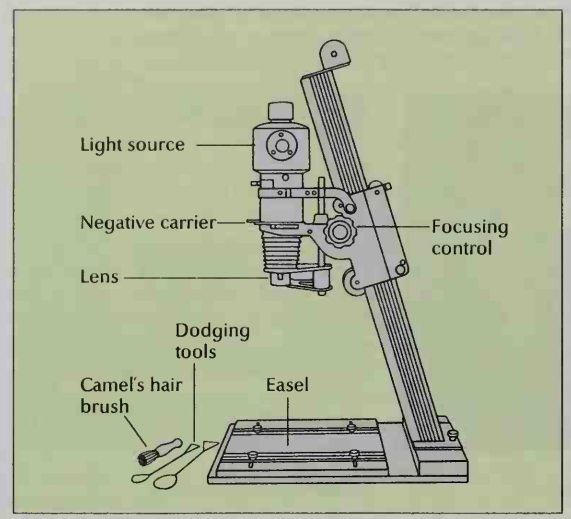
To dry the film, unwind it from the reel in the developing tank and hang it in a dust-free area. A clip or a clothespin should be attached to the lower end of the film to prevent the film from curling. As soon as the film has dried completely, cut it into strips of from four to six negatives. Store the strips of negatives in film envelopes in a clean, dry place. Negatives can easily be scratched or bent, and so you should handle them by the edges.

Printing black-and-white photographs is a process similar to making negatives. Printing paper is coated with an emulsion containing silver salts. During the printing process, light exposes the salts and forms a latent image on the printing paper. The paper must be developed before it can produce the visible image that will appear in the finished print.

To develop the printing paper, repeat the steps used in developing film. However, the paper is generally placed in open printing trays rather than in a developing tank, and different chemicals are used. To protect the latent image, you should work under a *safelight.* This kind of light illuminates the work area but does not expose the printing paper.

There are two principal methods of printing black-and-white photographs, *contact printing* and *projection printing.* Each process requires special equipment and produces a different type of print.

Contact printing is the simplest method. To make a



WORLD BOOK illustration by Robert Keys

An enlarger, the basic instrument used in projection printing, projects the image in a negative onto printing paper. Light passes through the negative and exposes the paper in the easel.

contact print, place the strips of negatives on a sheet of printing paper and cover them with a piece of glass. Use a *printing frame,* a *printing box,* or some similar device to hold the negatives and paper in place. Shine a light through the glass for a few seconds, and then remove the paper and develop it. If the print is too dark, repeat the process with a shorter exposure time. If the print is too light, use a longer exposure.

Contact printing is a quick, inexpensive way to preview photographs before making the final prints. Contact prints are the same size as the negatives, and so you can print an entire roll of film in one operation. For example, a 36-exposure roll of 35-millimeter film can be contact printed on a sheet of paper that measures 8 by 10 inches (20 by 25 centimeters).

Projection printing, also called *enlarging,* produces photographs that are larger than their negatives. In projection printing, the negative is placed in a device called an *enlarger.* The enlarger projects the negative image onto printing paper in much the same way as a slide projector throws an image onto a screen. The image on the printing paper is larger than that on the negative. The size of this projected image depends on the distance between the negative and the paper. The greater the distance, the larger the image.

Enlargers have three basic parts, the *head,* the *baseboard,* and a rigid column that supports the head and is connected to the baseboard. The head contains a lens, a carrier for the negative, and a source of light. Like many cameras, the enlarger head also has a focusing control and an adjustable aperture. An easel on the baseboard holds the printing paper. During the enlarging process, the lens focuses the negative image on the printing paper, and light from the light source passes through the negative and exposes the paper.

The head of an enlarger can be raised or lowered to change the size of the image on the printing paper. This flexibility in size enables you to change the composition of the picture as well as enlarge the size of prints. By making the image larger than the intended print, you can crop undesirable areas along the edges and reposition the elements of the picture.

Before using an enlarger, you should clean the negative carefully with a camel's-hair brush or an aerosol device. Particles of dust on a negative may show up as white spots on the finished prints. Place the negative in the carrier, turn on the enlarger light, and focus the image on a piece of plain white paper or cardboard in the easel. Next, adjust the aperture. For most prints, you should at first set the aperture at a medium f-stop, such as f/8. After the image has been focused and framed, turn off the enlarger light and the light in the work area and turn on the safelight. Then insert a sheet of printing paper into the easel.

The next step in the enlarging process is to determine the proper exposure time for the print by making *test strips.* Test strips are portions of a print that have been exposed for different amounts of time, generally ranging from 10 seconds to 50 seconds. After the test strips have been developed, you can decide which of the exposure times produced the best result. If all the test strips appear too light, open up the enlarger lens by two f-stops and make another set of strips. If the test strips are all too dark, close down the lens by two f-stops and repeat the procedure.

If only one area of the print turns out too light, you can darken the area by *burning in* the print. In this technique, a piece of cardboard with a small hole in it is held over the area to be darkened. Light passes through the hole in the cardboard and exposes the area, which then becomes darker. If an area of the print is too dark, it can be lightened by means of *dodging.* This procedure involves covering the dark area with a special dodging tool or a cardboard disk during part of the exposure time. The covered area will appear lighter in relation to the fully exposed parts of the print.

Overall contrast in prints is determined largely by the type of printing paper used. Printing papers are graded by number from 0 to 6 according to the degree of contrast produced in the prints. The higher the number, the greater the degree of contrast. A high-contrast paper, such as No. 4, is generally used to print a normal range of tones from a negative that has little contrast. Paper No. 1, a low-contrast paper, may be used to reduce the contrast in a negative that has extreme light and dark tones.

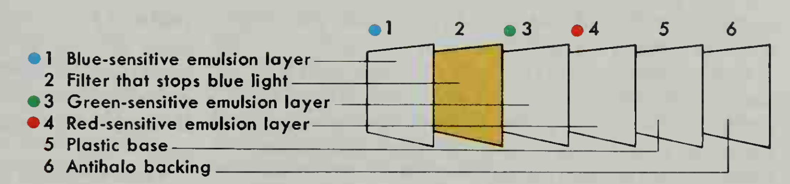
Some papers contain different grades of contrast. These *multicontrast papers* require different colors of light to produce each grade. You can change the color of the enlarger light by placing a colored printing filter over the lens.

In addition to contrast, printing papers vary in several characteristics that affect the appearance of prints. One of these characteristics is tone. In a photograph printed on *warm-toned paper,* the color black is reproduced as brown. On *cold-toned paper,* black appears blue. Another feature of printing papers is surface, which ranges from *matte* (dull) to glossy.

Developing color film involves the same basic procedures as black-and-white developing. However, the

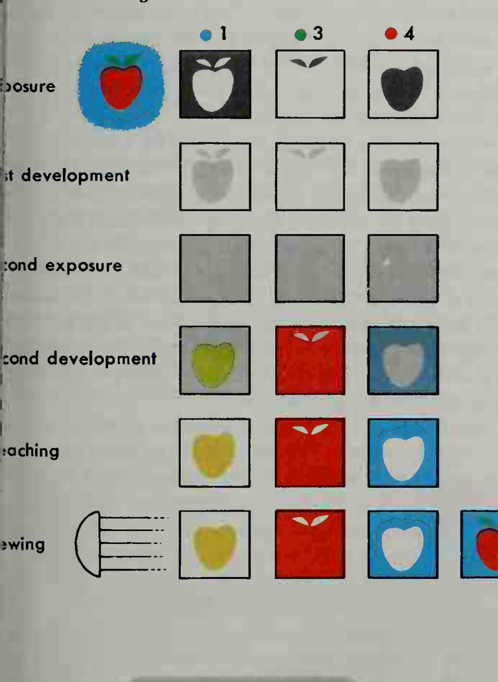
H w color film works

C or film consists of six layers: (1) an e ulsion that records blue, (2) a yellow fil- t that absorbs excess blue light, (3) an e ulsion that records green, (4) an emul- s n that records red, (5) a plastic base that s ports the emulsions, and (6) an *antihalo* b king that absorbs excess light.



H w color slides are made

C or slides are made from color reversal film. After exposure, t film contains images of the blue, green, and red areas of the s ject. The film then goes through two development proc- e es. The first development changes the exposed silver salts to r tallic silver. A negative silver image forms in each layer of the f n. Then the film is re-exposed so that the remaining silver s ts can be developed. During the second development, col- c d dyes form around the silver images on the film. The silver i hen bleached out of each image, leaving transparent film in t se areas. In the developed film, a yellow dye surrounds the i age made by blue light. A *magenta* (purplish-red) dye sur- r nds the image made by green light. A *cyan* (bluish-green) c surrounds the one formed by red light. When the film is r de into a slide and projected, each dye holds back light of its c nplementary color, and the original colors of the subject ap- p ar on the viewing screen.

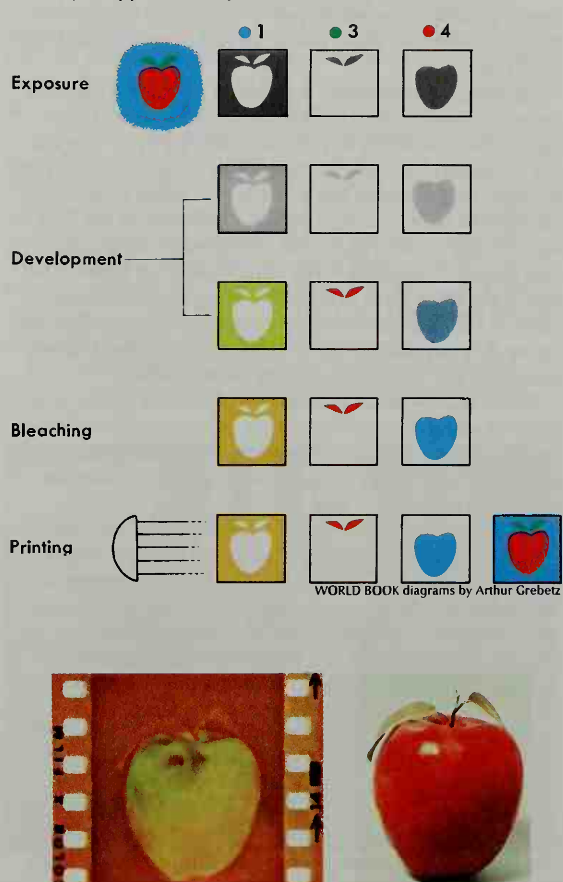




Color slide

How color prints are made

Color prints are made from color negative film. After exposure, the film contains images of the blue, green, and red areas of the subject. During development, the exposed silver salts produce a metallic silver image in each layer of the film. A colored dye forms over each image. The silver is then bleached out, leaving only the dye. In the negative, a yellow dye covers the image made by blue light. A magenta dye covers the image made by green light. A cyan dye covers the one formed by red light. These colors are hard to see because the negative has an overall orange tint that improves the color quality of prints. When the negative is printed, each dye holds back light of its complemen- tary color. The yellow dye absorbs blue light and lets red and green light pass through. The magenta dye absorbs green and lets blue and red through. The cyan dye absorbs red and lets blue and green go through. In this way, the original colors of the subject appear in the print.



WORLD BOOK diagrams by Arthur Grebetz

Negative film

Color print

chemical processes in color developing are much more complicated. To understand these processes, you need to know some of the basic principles of color.

Color depends chiefly on light. Although most light looks white to the eye, it is actually a mixture of three *primary colors*—blue, green, and red. Any color can be produced by blending these three colors of light. See Color (Mixing colored lights).

Color film contains three layers of emulsions. These emulsions are similar to the emulsion on black-and-white film. But in color film, each of the emulsions is sensitive to only one of the primary colors of light. During exposure, the first emulsion reacts only to blue light, the second emulsion only to green light, and the third only to red light.

When color film is exposed, light strikes the first emulsion and forms an image on the blue areas of the scene. The light then passes through the second emulsion, forming an image of the green areas. Finally, the light goes through the third emulsion and records an image of the red areas. Three latent images are thus recorded on the film.

The developing process changes color film in two main ways. First, the developer converts the exposed silver salts on the emulsions into metallic silver. The silver image produced on each layer of emulsion represents the color of light—blue, green, or red—that exposed the emulsion.

Second, the developer activates a substance called a *coupler* in each emulsion. Couplers unite with chemicals in the developer to produce colored dyes. The colors of the dyes are the *complements* (opposite colors) of the light that exposed the emulsions. Yellow is the complement of blue, and so a yellow dye forms in the first layer. In the second layer, the dye is *magenta* (purplish-red) because magenta is the complement of green. The dye in the third layer is *cyan* (bluish-green), the complement of red. Complementary colors are used as dyes because they reproduce the original colors of the subject when the film is processed into photographs.

Both color reversal film, which produces slides, and color negative film, which makes prints, record colored images in the same way. However, different materials and slightly different procedures are used to develop each type of film.

Color reversal film requires two different developers. The first developer changes the exposed silver salts on the film into metallic silver. The film is then reexposed or treated with a chemical agent so that the remaining silver salts can be developed. The second developer activates the couplers in the emulsions, causing colored dyes to form around the silver image in each emulsion layer. After the silver has been bleached out of the images, the images remain as transparent areas on the film. The developed film, called a *positive,* can be cut into separate pictures and mounted as slides.

On a slide, each area of the subject is transparent in one of the emulsion layers. In each of the other two layers, the area has a complementary color different from that of its original color. For example, the image of a blue sky would be transparent in the first emulsion layer. The image would be magenta (the complement of green) in the second layer and cyan (the complement of red) in the third layer. When light passes through the slide, each dye acts as a filter on a primary color. The magenta layer holds back green light, and the cyan layer holds back red light. As a result, only blue light passes through the transparent area of the slide, and the sky appears blue.

Color negative film is treated with only one developer. The developer converts the exposed silver salts into metallic silver and activates the dye couplers at the same time. After the developing procedure, each area of the subject appears on a layer of emulsion in a color complementary to the original color. For example, a blue object would be recorded as a yellow image on the first emulsion layer, and a green one would appear as a magenta image on the second layer. The colors of the images are reversed to their original shades during the printing process.

Printing color photographs involves the same chemical processes as those in the development of color film. Like color film, color printing paper has three layers of emulsions, each of which is sensitive to one of the primary colors of light. During printing, the yellow, magenta, and cyan dyes on the negative hold back light of their complementary colors—that is, each dye filters out one of the primary colors. Thus, the colors of light that expose the printing paper are the opposite of those that exposed the film. When the paper is developed, couplers in the emulsion layers form dyes that reproduce the colors of the subject.

Certain features of color prints can be changed by some of the same techniques used in black-and-white printing—adjusting the exposure, cropping, burning in, and dodging. In addition, the *color balance* of the prints can be adjusted by placing color filters over the enlarger lens. These filters, which are tinted in various shades of yellow, magenta, and cyan, reduce the intensity of the corresponding primary colors in the print. If the blue tones in the print are too strong, for example, you should put a yellow filter on the enlarger lens and repeat the printing procedure.

Color prints can be made from color slides as well as from color negatives. The same basic printing procedures are used in making slides and negatives. However, the effects of exposure are reversed with slides, which contain positive images. In printing from negatives, for example, a longer exposure makes a print darker. But in printing from slides, the same exposure time makes a print lighter. The effects of color filters are also reversed in making prints from slides. Strong colors in such prints are balanced by using filters of the same colors rather than of complementary colors.

Instant processing. Instant film produces prints in from 15 seconds to 8 minutes, depending on the type of film that is used. When the exposed film is taken out of an instant camera, it is covered by a lightproof sheath. This sheath can be either a sheet of paper or an *opaque* (nontransparent) layer of chemicals. The sheath serves as a kind of darkroom for the processing of the film. If the film has a paper sheath, the sheet of paper is peeled from the print after the specified developing time. If the film has a chemical sheath, the print is finished when the

que layer turns completely transparent.

nstant prints are processed in much the same way as tact prints. The chief difference between the two cedures is that the negative and the positive of an in- t print are developed at the same time rather than in arate stages.

nstant black-and-white film contains layers of nega- and positive emulsions, with a packet of jellylike de- oping chemicals between the layers. After exposure, film passes through a pair of steel rollers in the cam- The pressure of the rollers causes the packet to st, releasing the developing chemicals. The chemi- immediately convert the exposed silver salts on the negative layer into metallic silver. Within a few seconds, the unexposed salts move to the positive layer. There, they are changed into silver, forming a positive image on the print.

Instant color film has layers of colored dyes in addition to negative and positive emulsions and a packet of developing chemicals. When the chemicals are released, they develop the silver salts and activate the colored dyes at the same time. An image in colors complementary to those of the subject forms on the negative layer of emulsion. Then the image is transferred onto the positive emulsion layer, where the colors are reversed to the original ones.

History

arly developments. The ancient Greek philosopher stotle observed that light passing through a small e in the wall of a room formed an upside-down ge of an object. However, this characteristic of light not used to construct a camera until about A.D. 0, in Italy. The first crude camera, called a *camera ob- ra* (dark chamber), consisted of a huge box with a opening in one side that admitted light. On the op- site side of the box, the light formed an inverted ge of the scene outside. The camera obscura was je enough for a person to enter, and it was used efly by artists as a sketching aid. They traced the out- of the image formed inside the box and then col- d the picture. See **Camera obscura**.

camera obscura could only project images onto a een or a piece of paper. Scientists sought a way to ke the images permanent. In 1727, a German physi- t named Johann H. Schulze discovered that silver salts n dark when exposed to light. About 50 years later, l Scheele, a Swedish chemist, showed that the nges caused in the salts by light could be made per- nent by chemical treatment. However, these discov- es were not used for photography until the 1830's.

Meanwhile, a French inventor named Joseph Nicéphore Niépce found a way to produce a permanent image in a camera obscura. In 1826, he coated a metal plate with a light-sensitive chemical and then exposed the plate in the camera for about eight hours. The resulting picture, showing the view from Niépce's window, was the world's first photograph.

Niépce's technique was perfected during the 1830's by the French inventor Louis Daguerre. Daguerre exposed a sheet of silver-coated copper, developed the image with mercury vapor, and then "fixed" it with table salt. His pictures, called *daguerreotypes,* required a relatively short exposure of 15 to 30 seconds and produced sharp, detailed images. See **Daguerreotype**.

In 1839, the same year Daguerre patented his process, a British inventor named William H. Fox Talbot announced his invention of light-sensitive paper. This paper produced a negative from which positive prints could be made. Fox Talbot's friend, the astronomer Sir John Herschel, called the invention *photography.* Herschel suggested the use of sodium thiosulfate (hypo) as a fixing agent. Both Daguerre and Fox Talbot then began using this chemical in their processes.

Fox Talbot's paper prints, which were called *talbotypes* or *calotypes,* did not contain images as sharp as



The Gernsheim Collection, University of Texas at Austin

e first photograph, taken in 1826 by Joseph Nicéphore pce, a French physicist, shows a view from his window. He osed a light-sensitive metal plate for about eight hours.



Louis Daguerre, Société Française de Photographie, Paris

The daguerreotype was the first popular form of photography. It required a relatively short exposure. The earliest surviving daguerreotype, *above,* was made in 1837.

those of daguerreotypes. But the negative-to-positive process of making photographs had two important advantages. It produced many prints from one exposure, and the pictures could be included in books, newspapers, and other printed materials. See **Talbotype**.

In addition to the new developing and printing processes, photography was greatly improved during the 1840's by the introduction of specialized lenses. A Hungarian mathematician named Josef M. Petzval designed two types of lenses, one for making portraits and the other for landscape pictures. The portrait lens admitted much more light than previous lenses had and so reduced the exposure time to a few minutes. The landscape lens produced sharper pictures of large areas than previously had been possible.

The beginnings of modern photography. During the second half of the 1800's, scientists further improved photographic processes and the design of cameras. These advances enabled photographers to experiment with the artistic possibilities of photography.

Technical improvements. In 1851, a British photographer named Frederick S. Archer introduced a photographic process that greatly reduced exposure time and improved the quality of prints. In Archer's process, a glass plate was coated with a mixture of silver salts and an emulsion made of a wet, sticky substance called *collodion*. After being exposed for a few seconds, the plate was developed into a negative and then treated with a fixing agent. The collodion had to remain moist during exposure and developing, and so a photographer had to process pictures immediately after taking them. Many photographers traveled in wagons that served as a darkroom and a developing laboratory.

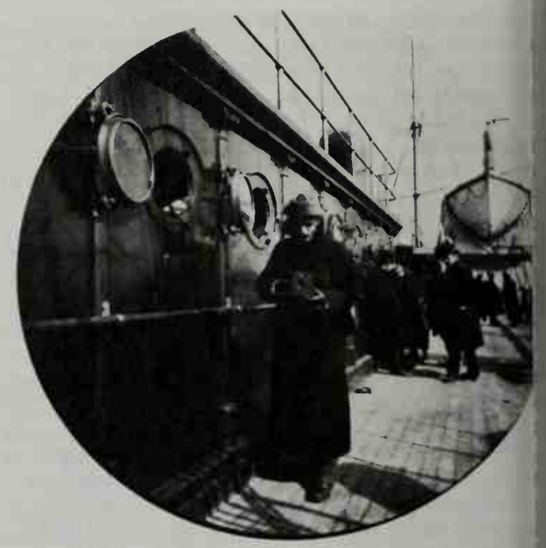
The invention of the *dry-plate process* overcame the inconvenience of the collodion method. In 1871, Richard L. Maddox, a British physician, used an emulsion of gelatin to coat photographic plates. Unlike collodion, gelatin dried on a plate without harming the silver salts. By using dry plates, photographers did not have to process a picture immediately.

The use of gelatin also eliminated the necessity of keeping a camera motionless on a tripod during exposure. By the late 1870's, improvements in the gelatin emulsion had reduced exposure time to $\frac{1}{25}$ of a second or even less. Photographers could now take pictures while holding the camera in their hands.

In addition to giving photographers greater mobility and freedom, the introduction of the gelatin emulsion revolutionized the design of cameras. Earlier types of printing paper could only be contact printed, and, therefore, negatives had to be as large as the intended print. But photos on paper coated with gelatin could be made by projection printing. Photographers could enlarge such pictures during the printing process, and so the size of negatives could be reduced. Smaller negatives meant smaller cameras.

In 1888, George Eastman, an American dry-plate manufacturer, introduced the Kodak box camera. The Kodak was the first camera designed specifically for mass production and amateur use. It was lightweight, inexpensive, and easy to operate.

The Kodak system also eliminated the need for pho-



George Eastman House, Rochester,

The Kodak camera, invented in 1888 by the U.S. manufactur George Eastman, made picture taking easy. This photo of him was taken with a Kodak identical with the one he is holding.

tographers to process their own pictures. The Kodak used a roll of gelatin-coated film that could record 100 round photographs. After a roll had been used, a pers sent the camera with the film inside to one of Eastman' processing plants. The plant developed the film, made prints, and then returned the camera loaded with a ne roll of film. The Kodak slogan declared: "You Press the Button, We Do the Rest."

Artistic advances. During the 1850's and 1860's, man people began to experiment with the artistic possibilities of photography. One of the first to use a camera cr atively was Gaspard Félix Tournachon, a French photog rapher who called himself Nadar. Nadar added a new element to portrait photography by emphasizing the pose and gestures characteristic of his subjects. However, his most famous achievement was the first aerial photograph, a view of Paris taken from a balloon.

Another pioneer in portrait photography was the Bri ish photographer Julia M. Cameron. She emphasized e pressiveness over technical quality, and so many of her pictures were blurred or out of focus. But Cameron ca tured the personalities of her subjects, who included such famous persons as Sir John Herschel and the British naturalist Charles Darwin.

Landscapes and architecture were also popular subjects for early art photographers. During the 1850's and 1860's, a number of governments commissioned photographers to make visual records of important buildings and natural features in various countries. Photographs were taken of historical sites in Europe and the Middle East, the scenery of the American West, and many other major landmarks. Some of these pictures were remarkable not only for their technical excellence but also for the effort involved in taking them. In 1861, for example, two French photographers named August

ɿd Louis Bisson withstood intense cold and avalanches
ι take pictures from the top of Mont Blanc in France.
e brothers needed so much equipment that they took
porters up the mountain with them.

Some of the most dramatic photographs of the mid-
00's are battlefield scenes. The earliest surviving pic-
es of this type were taken by Roger Fenton, a British
ırnalist covering the Crimean War (1853-1856). The
otos of the American Civil War (1861-1865) made by
athew Brady and his assistants rank among the finest
r pictures of all time.

During the late 1800's, some photographers used
eir pictures to dramatize issues, rather than simply
cord events or create artistic effects. One such pho-
grapher was William H. Jackson, an American, who
ecialized in photographing the Far West. Jackson's
otographs of the Yellowstone area helped persuade
ngress to establish the world's first national park
ere.

Two other American photographers, Jacob A. Riis and
wis W. Hine, took pictures that exposed social evils. In
88, Riis's photographs of the slums of New York City
ocked the public and helped bring about the abolition
one of the city's worst districts (see **Riis, Jacob A.**).
ne, who was a sociologist, documented the miserable
rking conditions of the poor. His pictures of children
rking in coal mines and dimly lighted factories
lped bring about the passage of child-labor laws. See
ild labor.**

The photographic revolution. By the late 1800's, the
velopment of photography was moving in two direc-
ns. The appearance of the Kodak camera and other in-
pensive box cameras had led to a tremendous rise in
e number of amateur photographers. Previously, pho-
graphy had been limited to people who knew how to
e complicated photographic equipment and could af-
d to buy this equipment. Now, almost anyone could
e a picture.

On the other hand, some photographers wanted photography to be considered a creative art in the tradition of drawing and painting. Many of these *pictorial photographers* tried to make their prints look like paintings. They used special printing techniques and paper to give their photographs a texture similar to that of painted canvases. Some photographers even colored the images with paint. In 1902, Alfred Stieglitz, Edward Steichen, and a number of other American photographers formed a group to promote photography as an independent art form. This group, which was called the Photo-Secession, organized photographic exhibitions in the United States and loaned collections of photos to exhibitors in many other countries.

The idea that photographers should imitate painters was soon challenged. After about 1910, many photographers believed that unretouched photographs had a beauty and elegance unmatched by other works of art. Their ideal of "pure" photography influenced such later photographers as Edward Weston and Paul Strand of the United States.

During the 1920's and early 1930's, photography underwent dramatic changes as the result of two major developments. First, photographic equipment was revolutionized by the miniature 35-millimeter camera and artificial lighting. The Leica camera, introduced in 1924 in Germany, was small enough to fit in a pocket, but it produced clear, detailed photographs. Many photographers used the Leica to take *candid pictures,* in which people did not know they were being photographed. The electric flashbulb, introduced in 1929, and electronic flash, invented in 1931, greatly expanded the range of photographic subjects.

The second major development involved experimentation with new ways of composing pictures and viewing subjects. László Moholy-Nagy, a Hungarian, and Man Ray, an American, produced photographs without using a camera. They placed objects on a piece of printing paper and exposed the paper with a flashlight. Other photographers created abstract compositions with X-ray

The Library of Congress, Washington, D.C.



News photography was born during the mid-1800's with the work of Mathew Brady of the United States and other photographers. Brady's pictures of the American Civil War captured both the horror of the battlefield and the humanity of the soldiers. Brady processed his photos by the *collodion method,* which required an enormous amount of equipment. His photographic van can be seen at the right of this picture.

photographs and multiple exposures. The French photographer Henri Cartier-Bresson was one of the first to utilize the creative possibilities of the miniature camera. He tried to capture people's gestures and feelings at "decisive moments" of their lives.

A technique called *documentary photography* developed in the 1930's. During the Great Depression, the Department of Agriculture hired photographers to survey conditions in rural areas of the United States. The outstanding photographers involved in this project included Walker Evans and Dorothea Lange. Their pictures portray the courage and suffering of poverty-stricken farm families. At the same time, the appearance of illustrated news magazines in Europe and the United States created a demand for news photographs. Such photojournalists as Margaret Bourke-White and Robert Capa, both of the United States, vividly recorded some of the most important people and dramatic events of the period.

Other photographers of the 1930's and 1940's concentrated on ordinary subjects or natural scenery. Many pictures taken by Edward Weston and Paul Strand emphasize the textures and geometric shapes of everyday objects. Weston and Strand helped develop the technique of *straight photography,* which features sharply focused, detailed images. Another American photographer, Ansel Adams, specialized in landscapes, especially the mountains and deserts of the West.

During the 1950's and 1960's, photographic styles became increasingly varied, particularly in the United States. The "street photography" of such photographers as Robert Frank and Garry Winogrand followed the tradition of documentary realism. Other photographers experimented with various printing techniques to achieve unusual effects. For example, Robert Heinecken produced some of the most imaginative photographs by making contact prints directly from the illustrated pages of magazines. Other photographers, including Minor White and Aaron Siskind, tried to convey a highly personal, almost spiritual view of the world in their work.



Migrant Girl (1936); The Library of Congress, Washington, D.C.

Documentary photographs may persuade as well as inform. The sensitive portraits of migrant farmworkers by U.S. photographer Dorothea Lange aroused public concern over their plight.

The artistic possibilities of color photography were not fully explored until the 1970's. Color film had been popular among amateur photographers since it was first commercially produced in 1935. However, most professional photographers continued to work almost entirely with black-and-white film. The American photographers Ernst Haas and Marie Cosindas were among the first professionals to concentrate on color photography. Haas's work includes both realistic landscapes and abstract compositions. Cosindas, who chiefly uses instant color film, specializes in still lifes and portraits.

Photography today is firmly established as both an art form and an essential tool in communication and research. Nearly all major art museums hold exhibitions of photographs, and a number of museums specialize in photographic art. A picture by a well-known photographer, such as Paul Strand, may cost as much as a fine painting. At the same time, the practical value of photography has steadily risen in many fields, ranging from advertising to zoology.

Professional photography includes a greater variety of styles and themes than ever before. But much of the work can be broadly classified as either *realistic* or *fanciful.* Among the outstanding realistic photographers are Donald McCullin of Britain and Lee Friedlander of the United States. Many of their photographs vividly document the "social landscape" of their countries. Another realistic photographer is Harry Callahan of the United States, whose work includes detailed, sharply focused pictures that follow the principles of straight photography.

Fanciful photographers may distort the appearance of objects in their pictures to create an illusion or convey a mood. The American photographer Jerry Uelsmann produces dreamlike images by combining several negatives into a single print. Another American photographer, Eileen Cowin, poses herself and her family in settings that suggest images from television soap operas.

Amateur photographers use a wide variety of equipment and techniques. Cameras range from simple fixed-focus models to adjustable ones that have interchangeable lenses and many built-in features. Home processing of both black-and-white and color film has been simplified by easy-to-use equipment and fast-acting chemicals. Amateurs also shoot color home movies with available light, and they make videotape movies that can be shown on a television set.

One of the greatest technical advances in both amateur and professional photography has been the instant processing of film. Ever since the instant camera was introduced in 1947, manufacturers have steadily improved the efficiency and ease of instant processing. The original model was bulky and expensive. But some of today's instant cameras are about the size of a paperback book and cost no more than a good standard camera. Many studio cameras can be adapted for instant photography by means of special attachments.

Careers

hotography offers a wide variety of challenging ca- r opportunities. A person interested in a career in otography should have a general academic back- und and technical knowledge of photography. Many colleges and universities offer courses in pho- raphy, and some have programs that lead to ad- ced degrees in the subject. A number of art schools l technical schools also offer instruction and practical ning in photography. Information about careers in otography can be obtained from Professional Photog- hers of America, Inc., in Des Plaines, Illinois.

Commercial photography. Most commercial pho- raphers take pictures for advertisements or for illus- ions that appear in books, magazines, and other pub- tions. These photographers work with subjects as ied as food, farm equipment, and high-fashion cloth- , and they may be assigned to take photographs at a iety of locations. Commercial photographers must be lled and imaginative in a wide range of photographic hniques.

Portraiture. A portrait photographer takes pictures eople and of special events in the lives of these indi- uals. Some photographers in this field specialize in e type of portraiture, such as children, families, or ddings. Portrait photographers must know how to se their subjects and how to create pleasing effects.

Photojournalism. Most photojournalists take pic- es for newspapers or newsmagazines. They must be lled in seeking out and recording dramatic action in h fields as politics and sports. A photojournalist must o take pictures rapidly and process them quickly.

Scientific photography includes an increasing num- r of specialized areas. Major fields of scientific pho- raphy include *medical photography* and *engineering otography.* Medical photographers provide informa- n used by physicians to diagnose and treat illnesses. ese photographers may work with such medical uipment as microscopes, X-ray machines, and in- red scanning systems. Engineering photographers p engineers improve the design of equipment and uctural materials. These photographers sometimes e special cameras to "stop" the action of machines and make visible the flaws in metal, plastic, and other ma- ials.

Other fields in photography include research, manu- turing, and film processing as well as business man- ement and sales. Careers are also open to people o can teach photography or write about it. In addi- n, a growing number of museums employ people o are experts in the history of photography.

ohn Hedgecoe

Study aids

Related articles in *World Book* include:

Biographies

ams, Ansel
rke-White, Margaret
dy, Mathew B.
neron, Julia M.
tier-Bresson, Henri
Daguerre, Louis J. M.
Eastman, George
Edgerton, Harold E.
Eisenstaedt, Alfred
Evans, Walker
Jackson, William H.
Karsh, Yousuf
Land, Edwin H.
Lange, Dorothea
Lumière brothers
Niépce, Joseph N.
Ray, Man
Riis, Jacob A.
Steichen, Edward
Stieglitz, Alfred
Strand, Paul
Weston, Edward

Photographic equipment

Airbrush
Camcorder
Camera
Lens
Light meter
Projection screen
Projector
Stereoscope

Types of photography

Animation
Copying machine
Daguerreotype
Holography
Kirlian photography
Motion picture
Photoengraving and photolithography
Photogrammetry
Talbotype

Other related articles

Astronomy
Ballistics (picture)
Blueprint
Camera obscura
Color
Eastman Kodak Company
Filmstrip
Infrared rays
Light
Microfilm
Modeling
Polarized light
Pulitzer Prizes (News photography)
Videotape recorder

Outline

I. The photographic process
- A. Capturing light rays
- B. Focusing the image
- C. Exposing the film
- D. Developing the film
- E. Making a print

II. Taking photographs
- A. Composition
- B. Light
- C. Focusing
- D. Exposure

III. Photographic equipment
- A. Cameras
- B. Film
- C. Lighting equipment
- D. Filters
- E. Tripods

IV. Developing and printing
- A. Developing black-and-white film
- B. Printing black-and-white photographs
- C. Developing color film
- D. Printing color photographs
- E. Instant processing

V. History

VI. Careers

Questions

What is *depth of field?* How can it be controlled?
How does contact printing differ from enlarging?
Why do photographers use filters on cameras?
What are some common mistakes in taking pictures?
How did William H. Fox Talbot contribute to the development of photography?
Which two controls on a camera regulate exposure?
Why is a fixer used in developing and printing?
How can you photograph a fast-moving subject?
What are some types of specialized lenses?
What causes graininess in a photograph?

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Photolithography. See Photoengraving and photolithography.

Photomultiplier tube is an extremely sensitive electric eye vacuum tube. Most of these tubes are more sensitive to light than is the human eye. Photomultipliers are used to measure very weak light. For example, physicists use them in scintillation counters to measure the light given off by cosmic rays, nuclear particles, gamma rays, or X rays.

A photomultiplier has a *photocathode,* which gives off electrons when light strikes it. These electrons then strike the first of a series of plates called *dynodes.* As the electrons bounce from plate to plate, they knock an ever-increasing number of electrons from each plate. Several million electrons may leave the tube for every electron given off by the photocathode. The tube thus multiplies the effect of the light that strikes it and enables the brightness of the light to be measured with extreme accuracy. Paul L. Gerace

Photon, *FOH tahn,* is the elementary particle that makes up light and all other forms of electromagnetic radiation. Like all particles, photons have properties of waves, including frequency and wavelength. But photons have no mass and no electric charge. The speed at which photons travel in a vacuum is the speed of light. The exchange of photons between electrically charged particles transmits the electromagnetic force, one of the four fundamental forces.

In 1900, the German physicist Max Planck showed that the energy of a photon (then called a *radiation quantum)* is proportional to the frequency of its light. The German-born physicist Albert Einstein carried Planck's discovery further. In 1905, Einstein used the idea of photons to explain the ability of light to knock electrons out of atoms—a phenomenon known as the *photoelectric effect.* His predictions about photons, which were later confirmed by experiment, contributed much to the development of the quantum theory. Joel R. Primack

See also **Light** (Photons); **Quantum mechanics; Radiation.**

Photoperiodism, *FOH toh PIHR ee uh dihz uhm,* is the ability of plants and animals to detect the relative length of daily light and darkness in their environment. Seasonal changes in the length of the day affect such activities as bird migration and the reproductive behavior of plants and animals.

There are three main types of photoperiodic responses. *Short-day responses* occur when the period of light each day is shorter than a certain length of time. For example, in the fall, many birds migrate south in response to shortening days. *Long-day responses* occur when the period of light each day is longer than a certain length of time. In the spring, many plants flower in response to lengthening days. *Day-neutral responses* occur equally well during both long and short days. For example, some plants flower when they reach a certain size, regardless of the length of day. Gerald F. Deitzer

Photosynthesis, *FOH tuh SIHN thuh sihs* or *FOH toh SIHN thuh sihs,* is a food-making process that occurs in green plants. Photosynthesis is the chief function of leaves. The word *photosynthesis* means *putting together with light.*

Green plants use energy from light to combine carbon dioxide and water to make food. All our food comes from this important energy-converting activity of green plants. Light energy is converted to chemical energy and is stored in the food that is made by green plants. Animals eat the plants, and we eat animal products as well as plants.

The light used in photosynthesis is absorbed by a green pigment called *chlorophyll.* Each food-making cell in a plant leaf contains chlorophyll in small bodies called *chloroplasts.* In chloroplasts, light energy causes water drawn from the soil to split into molecules of hydrogen and oxygen. In a series of complicated steps, the hydrogen combines with carbon dioxide from the air, forming a simple sugar. Oxygen from the water molecules is given off in the process. From sugar—together with nitrogen, sulfur, and phosphorus from the soil—green plants can make starch, fat, protein, vitamins, and other complex compounds essential for life. Photosynthesis provides the chemical energy needed to produce these compounds.

Certain bacteria and algae can also capture light energy and use it to make food. For example, *photosynthetic bacteria* contain chlorophyll in tiny bodies called *chromatophores.* In chromatophores, compounds other than water are combined with carbon dioxide to form sugar. No oxygen is released.

Green plants convert carbon dioxide and water into food and oxygen. Plants and animals, in turn, "burn" the food by combining it with oxygen to release energy for growth and other activities of life. This process, which is called *respiration,* is the reverse of photosynthesis. Oxygen is used up and carbon dioxide and water are given off. Plants then use the carbon dioxide and water to produce more food and oxygen. The cycle of photosynthesis and respiration maintains the earth's natural balance of carbon dioxide and oxygen. David H. Wagner

See also **Leaf** (How a leaf makes food; illustration); **Chlorophyll; Respiration.**

Phototypesetting. See Photocomposition.

Phrenology, *frih NAHL uh jee,* is the practice of analyzing a person's character by examining the shape of the skull. Phrenology was developed during the early 1800's by two German physicians, Franz Joseph Gall and Johann Kaspar Spurzheim. Phrenology was once considered a science. Most people now regard it as a *pseudoscience* (false science).

Phrenology was based on the belief that different areas of the brain control different aspects of behavior. Gall and Spurzheim believed the skull could be mapped to show the locations of these areas, which they called *organs.* Some organs governed personality traits, and others controlled mental abilities.

According to phrenologists, a person's outstanding traits could be identified by bumps or bulges on the head. These swellings were caused by the enlargement of the organs related to each powerful trait. For example, a musician would have a well-developed *organ of tune* and a mathematician would possess a large *organ*

number. Phrenologists also believed that certain
mps identified people as poets or thieves.
Phrenology gained great popularity in Western Eu-
e and North America during the early and mid-
00's. Notable people who believed in phrenology in-
ded Queen Victoria of Britain and the American
ets Walt Whitman and Edgar Allan Poe.
Today, scientists know that a personality trait is not lo-
ized in any one area of the brain. Different parts of the
in have different functions, but the parts interact in a
re complex way than phrenologists realized. Never-
less, phrenology did help pave the way for the scien-
c study of personality, and thus for modern psycholo-
Christopher McIntosh

rygia, *FRIHJ ee uh,* was an ancient country between
Mediterranean Sea and the Black Sea, in what is
w central Turkey. The Phrygians were an Indo-Euro-
an people who came from southeastern Europe after
00 B.C. and settled in lands once ruled by the Hittites.
gends tell that the early Phrygian kings included
rdius and Midas, whose great rock tombs may still
seen in the mountains. See **Gordian knot; Midas.**
Cimmerians—invaders from around the Caucasus
ountains—conquered Phrygia about 700 B.C. Phrygian
mmunities still existed to about 550 B.C. The Phrygians
er came under Persian, Greek, and Roman rule. They
re known for their art and ceramics, and skill in
nb-building. They contributed many Oriental ideas to
early Greeks, especially in music. The Romans
opted the Phrygian worship of the goddess Cybele,
o was the Great Mother of the Gods. Ronald P. Legon

hyfe, *fyf,* **Duncan** (1768-1854), a well-known Ameri-
n cabinetmaker and furniture designer, popularized
Federal style of American furniture. He adopted that
le from the English neoclassical style of the mid-
00's.
Phyfe based his designs on English pattern books of
day, especially those of Thomas Sheraton and
omas Hope. Phyfe became known for his chairs,
nches, and other seating furniture. He manufactured
airs with backs shaped like scrolls. The chairs had a
lat—a piece of wood that formed the center of the
ck. A typical splat was shaped like a harp or a lyre.
Phyfe was born in Loch Fannich near Inverness, Scot-
nd. He emigrated to America in 1782. By 1792, Phyfe
d established a shop in New York City. He eventually
erated one of the largest furniture factories in the
ited States. Nancy E. Richards
See also **Furniture** (Early American furniture).

hylloxera, *FIHL ahk SIHR uh,* is any one of a group of
all insects that resemble *aphids* (plant lice). They feed
trees and shrubs.
One of the most important kinds of phylloxerae is the
ape phylloxera. This insect sucks the sap from the
ves and roots of grapevines, causing *galls* (swellings).
e damage to the root stunts and often kills the vine.
e grape phylloxera is native to the eastern United
ates. The vines in this region resist them, but these in-
cts do much damage in the western United States and
Europe. They are controlled by grafting the vines to
otstock from the eastern United States and by periodi-
lly flooding or fumigating the soil.
The life cycle of the grape phylloxera lasts two years.
rtilized eggs are laid under the bark of the vine in the
fall. In the spring, these eggs hatch into wingless young that move to the leaves to feed. They lay unfertilized eggs, which soon hatch. Several of these generations are produced during the summer. In the fall, the young insects move to the roots and hibernate there during the winter. During the next spring and summer they feed on the roots and produce young from unfertilized eggs. As fall approaches, winged insects are produced that lay eggs in other vines. After these eggs hatch, the insects mate, the females lay fertilized eggs, and the cycle repeats.
John R. Meyer



© Jack K. Clark, Comstock

Grape phylloxerae, small aphidlike insects, attack a root of a grapevine.

Scientific classification. Phylloxerae are in the family Phylloxeridae. The scientific name for the grape phylloxera is *Daktulosphaira vitifoliae.*

Phylum. See Classification, Scientific.

Physical change is a change of matter from one form to another without the production of any new substances. All chemical compounds present before the physical change are present afterward. Because no change in chemical structure occurs, there is no change in solubility, taste, odor, or ability to react chemically. For example, when wood is turned into sawdust, the change is physical. But if the wood were burned, new substances, ash and gas, would result, so the change would be chemical. Another example of a physical change is the melting of ice to water. Lucille B. Garmon

Physical chemistry is the study of the general rules and principles that govern the chemical properties of matter. Physical chemistry is primarily concerned with (1) whether a particular chemical reaction will occur and (2) how fast and by what mechanism the reaction will proceed. The study deals with such problems as how and why atoms join together in molecules; how atoms and molecules form gases, liquids, and solids; how atoms and molecules absorb and emit energy; and how electricity relates to chemistry. Raymond P. Borkowski

See also **Chemistry** (Development of physical chemistry).

Physical disability. See Disabled.

Physical education is a part of the school instructional program that focuses on development through participation in various forms of bodily activity. Physical education programs encourage students to develop skills and enjoyment of exercise that will help them remain active throughout their lives. Courses in physical education are offered in all grades, from preschool through college. Students participate in a wide variety of activities, including basic movement, dance, fitness, games, recreational activities, and sports.

Teachers help students learn to enjoy physical activity by creating a noncompetitive environment that encourages individual development. Within such a supportive environment, students improve their fitness and basic motor skills, such as running and jumping. They also take part in a variety of games and sports. As students

participate, they develop skills and strategies and increase their enjoyment of exercise.

Elementary school programs

Physical education programs in preschool through grade 2 focus on basic motor skills. Educators call this approach *movement education.* Teachers also encourage individual development and help students extend their basic skills with the *problem-solving method.* In this method, students work out their own solutions to a problem, such as how to balance on a narrow beam.

Programs in grades 1 and 2 also include elementary games, which stress participation by all students and cooperation rather than competition. Through participation in these games, children learn how to behave in play situations and how to get along with others in a group. Dance activities and exercises done to music are also included in these programs.

Programs in grades 3 and 4 help youngsters begin to develop the skills needed for many popular activities and sports. Children play simplified forms of such games as basketball, soccer, and volleyball. They also take part in gymnastics and track-and-field events.

In grades 5 and 6, students learn more advanced skills and strategies in team sports, such as softball and soccer. They also begin to learn individual sports, such as archery and golf. If facilities are available, they begin swimming and other water activities.

In grades 7 and 8, students learn more about fitness and strength development. Instructors may also introduce cooperative adventure games that require group problem solving. These games develop decision making, leadership, and cooperation skills.

Secondary school programs

Physical education programs in junior and senior high school continue instruction in many activities offered i elementary school programs. The teachers provide more advanced instruction, however, and the activities are more organized and demanding. The programs als add new sports, such as field hockey and badminton.

High school programs consist chiefly of sports that are popular lifetime recreational activities. Examples in clude bowling, bicycling, handball, skating, and tennis. Instructors regularly evaluate student performance anc knowledge in fitness and sports.

Some high schools allow juniors and seniors to choose part of their physical education program from number of nonrequired activities called *electives.* Students also may participate for credit in independent study projects or in a sports program outside school.

A growing number of high schools offer special courses in physical fitness. These courses combine classroom studies, laboratory tests to measure fitness, and individually designed exercise programs.

Many junior and senior high schools offer *interscholastic* sports, in which schools compete against each other, as an extension of their physical education programs. Popular interscholastic sports include baske ball, football, volleyball, soccer, gymnastics, and tennis Many schools also offer *intramural* programs, which in volve students from the same school. Intramural programs enable students to participate in sports tournaments and recreational activities after school.

University and college programs

Most colleges and universities offer physical education programs. Students at some schools must take one or two years of physical education. At other schools, these courses are optional. College-level students may continue a sport they played in high school or learn a new one. Large universities offer many activities not



© Ellis Herwig from Marilyn Gartm

Elementary-school children do arm exercises in this physical education class to develop and understand basic movements.

ilable at smaller schools, such as sailing and skiing.
Many colleges and universities offer bachelor's de-
es in physical education. These degrees require the
dy of such subjects as anatomy, sports techniques,
teaching methods. Some institutions also offer mas-
or doctor's degrees in physical education.

History of physical education

arly history. Many experts trace the origins of mod-
physical education to the ancient Greeks, who had
eloped organized physical education programs by
700's B.C. Greek boys attended educational facilities
ed *gymnasiums,* where they received physical and
tary training. Some gymnasiums also provided in-
iction in philosophy and other subjects. At the gym-
iums, boys took part in jumping, running, and
stling. They also practiced throwing a platter-shaped
ect called the *discus* and a spear called the *javelin.*
ancient Rome, physical education served chiefly as
paration for battle. Soldiers practiced swimming,
ning, jumping, and throwing to increase their fitness.
he Middle Ages, which began in the A.D. 400's and
ed until about the 1500's, were marked by a decline
ll types of formal schooling, including physical edu-
on. People of this time considered many sports and
er physical activities sinful.
uring the Renaissance, a period lasting from about
0 to about 1600, many Greek and Roman educational
as were revived. Students again took part in boxing,
mming, and other body-building activities.

uring the 1800's, physical education programs
e introduced into schools in Germany, Sweden, and
United Kingdom. German and Swedish programs
ured gymnastics and exercise routines. British
ools emphasized team sports. Physical education
ead to the United States during the mid-1800's under
h names as *physical culture* and *physical training.*
U.S. programs borrowed activities and teaching
thods from the European programs.
ntercollegiate competition in baseball, football, and
er sports began during the late 1800's and early
0's. These sports grew rapidly in popularity and led
ncreased interest in physical education.

uring the 1900's, physical education began to in-
de groups that formerly were denied chances to par-
pate. For example, few female students took physical
ication until the late 1800's, and even then most class-
vere segregated by sex. By the late 1900's, most phys-
education classes included both sexes. Males and
ales competed separately in only a few sports, and
ny more sports became available to females. In addi-
, federal laws passed in 1969 and 1970 required
ools receiving federal funds to provide physical edu-
on programs for students with disabilities at all edu-
onal levels.
uring the 1990's, physical education gained new em-
sis because of scientific studies showing that exer-
improves health. In 1996, the surgeon general of the
ted States released a report on physical activity and
lth. This report said that regular, moderate exercise
significantly reduce the risk of dying from heart dis-
e, high blood pressure, colon cancer, and diabetes.
report noted, however, that almost half of American
ths from 12 to 21 years old are not regularly active.
Several other studies in the 1990's showed that children had less strength and endurance, and more weight problems than earlier generations of children had. The U.S. Centers for Disease Control and Prevention began a major effort to help states, national organizations, and professional groups promote physical activity.

Physical education today stresses helping children develop good exercise habits and a healthy lifestyle, rather than win competitions. As a result, schools put new emphasis on preparing students for lifelong fitness based on regular physical activity.

Careers in physical education

Most careers in physical education involve teaching. Physical education teachers in public schools must have a bachelor's degree and a *teaching certificate,* a license to teach awarded by each state. Many physical education teachers also coach interscholastic sports.

Physical education instructors in colleges and universities teach classes and direct intramural sports. They also give teacher-training classes for future physical education teachers. In addition, some physical education teachers coach intercollegiate sports. Many instructors at the college level have a master's or doctor's degree.

Other individuals with degrees in physical education direct recreation programs at day-care centers, parks, or prisons. Some careers in physical education—for example, athletic trainer or sports administrator—require both training in physical education and additional study in a related field. Daryl Siedentop

Related articles in *World Book* include:

Game
Gulick, Luther Halsey
Gymnasium
Health
Naismith, James
Physical fitness
Play
Playground
Recreation
Sports

Physical fitness

Physical fitness is the ability to meet the physical demands of daily life and to resist diseases associated with inactivity. Physical fitness enables people to perform well in sports and other activities, and to look and feel their best.

Physical fitness can be classified into two main kinds: (1) performance-related and (2) health-related. People face different physical demands in the course of their occupations and leisure time. Therefore, the necessary type of conditioning, which may be called performance-related physical fitness, varies from one individual to another. For example, a stockbroker who runs marathon races for recreation requires a high capacity of the heart and lungs to deliver oxygen to leg muscles. On the other hand, a factory worker who lifts heavy crates but reads for relaxation primarily requires great leg and upper body strength to meet daily physical challenges.

The requirements for health-related fitness are similar for all people. Everyone must maintain certain aspects of health-related fitness to feel good and to resist disease.

Performance-related fitness

Performance-related physical fitness includes such qualities as muscular strength, aerobic power, anaerobic power, anaerobic capacity, and flexibility.

Muscular strength is the ability to produce force in a single effort. This type of strength is vital to such athletes as discus and javelin throwers, football linemen, shot-putters, and powerlifters.

Some ways to achieve physical fitness

Women in a physical fitness class exercise to keep their muscles strong and limber, *left.* Runners race in the park to build their strength and endurance, *center.* Many people keep fit by maintaining an exercise program that includes weightlifting on specialized machines, *right.*

© Annie Griffiths, West Light



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Ellis Herwig, Stock, Bo

Aerobic power is the highest rate at which a person's body can produce energy in the muscles through the use of oxygen. Aerobic power depends on good lung function to supply oxygen to the blood, a strong heart to pump blood to the muscles, and muscles that are efficient in using the oxygen sent to them. Great aerobic power is common among endurance athletes, including cyclists, distance runners, rowers, and distance swimmers. These athletes may have twice the aerobic power of untrained people.

Anaerobic power is the ability to produce great force quickly, a combination of speed and strength. The term *anaerobic* means *without oxygen.* Highly anaerobic activities use up energy so fast that they can be sustained for only 30 seconds or less. Anaerobic power is needed in such events as the high jump, long jump, 50- to 100-meter sprints in track, rebounding in basketball, and weightlifting.

Anaerobic capacity is the ability to sustain great force for up to 30 seconds. It is important in 200- and 300-meter sprints in track; 25- and 50-meter swims; and any sport involving brief bursts of maximum effort.

Flexibility is the range of motion of body joints. Great flexibility is needed in such activities as dance, gymnastics, high jumping, hurdling, long jumping, and wrestling. A high degree of flexibility may also help prevent certain sports injuries.

Health-related fitness

Health-related fitness includes such qualities as aerobic power, flexibility of the spine, abdominal strength, body fat, cholesterol levels, and glucose tolerance.

Aerobic power enables a person to comfortably perform such activities as cycling, racquetball, rowing, running, stair climbing, swimming, vigorous walking, or yard work. Participation in aerobic activities on a regular basis can reduce the risk of *coronary artery disease,* tl most common form of heart disease. Along with diet control, these activities can also help prevent *obesity* (being too fat) and *osteoporosis* (loss of bone tissue).

Flexibility of the spine involves the range of motic of the joints of the spinal column. It is important for re ducing the risk of low back pain. When in a sitting pos tion with both legs extended, a person should be able reach within about 4 inches (10 centimeters) of his or her toes.

Abdominal strength also helps reduce back pain. The abdominal muscles should be strong enough for person to do about 20 bent-knee sit-ups easily.

Body fat. The percentage of body tissue that consis of fat and the distribution of that fat are important factors in a wide variety of diseases. The percentages of body fat for young adult men should fall between abo 5 and 20 percent and between about 12 and 30 percer for young adult women. Levels over 20 percent in mer and 30 percent in women contribute to health risks, in cluding arthritis, diabetes, gall-bladder disease, heart disease, and high blood pressure. People whose fat is mainly in the abdominal area have a greater risk of he disease than people whose fat accumulates chiefly in the hips and thighs. Exercise helps prevent excess fat.

Cholesterol levels. Cholesterol is a waxy, fatty sub stance found in animal tissues and the food that come from them. High levels of cholesterol in the blood increase a person's risk of coronary artery disease. Mor important than the total amount of cholesterol, howev are the relative amounts of *lipoproteins,* large molecules that carry cholesterol through the blood. There are two main types of cholesterol-carrying lipoproteir (1) *low-density lipoproteins (LDL's)* and (2) *high-density lipoproteins (HDL's).* Cholesterol in the blood can be identified as either LDL-cholesterol or HDL-cholestero

pending on which lipoprotein carries it. High levels of L-cholesterol increase the risk of coronary artery dis-e, but HDL-cholesterol seems to reduce that risk. ple who engage in regular aerobic exercise lower ir levels of harmful LDL's and increase their beneficial L's. See **Cholesterol**.

Glucose tolerance is how the body responds to a ding of a sugar called *glucose*. Healthy people can sume foods containing glucose without developing essive amounts of glucose in their blood. Elevated els of glucose in the blood indicate *diabetes mellitus,* rious disease in which the body cannot use glucose mally. Regular aerobic exercise may improve glu-e tolerance and improve the function of *insulin,* a mone that regulates blood glucose.

Developing physical fitness

To achieve and maintain physical fitness, people uld eat a balanced diet and exercise regularly. A bal-ed diet includes all the nutrients the body needs to ain healthy. Nutritionists have developed various delines to encourage good nutrition. See **Nutrition** trition guidelines).

Physical education programs in schools help children elop good fitness habits. In the United States, the sident's Council on Physical Fitness and Sports rec-mends that all elementary and high schools provide eriod of at least 20 to 30 minutes of vigorous exercise ly. An effective school program also offers team rts, courses in health care, and performance tests to asure students' progress in physical fitness.

Health experts recommend at least 20 minutes of vig-us aerobic exercise three to five times per week for lts to develop and maintain aerobic power and to p control body fat, cholesterol, and glucose toler-e. But a less vigorous exercise program can also e important health benefits, especially for reducing risk of heart disease. Such a program should include minutes or more of moderate exercise—such as walk-, easy bicycling, or gardening—at least five days a ek. Men over age 40, women over 50, and anyone h risk factors or symptoms of heart or lung disease uld check with their physicians before starting a vig-us exercise program. David R. Lamb

Related articles. See Sports and its list of *Related articles.* also:

obics	Jogging
ng (picture)	Physical education
lth (Exercise)	T'ai chi chuan
rt (Coronary artery disease)	Weight control

Additional resources

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ysical science. See Science (The physical sci-es).

ysical therapy is the use of physical means, such ight, heat, cold, and exercise, to treat disease or in-. Physical therapy is used to help prevent, relieve, or rect conditions that interfere with a person's physical lity to function normally. It is administered by health e professionals called *physical therapists.*

Uses of physical therapy. Physical therapy is helpful in treating many diseases and disabilities. It is often used in treating heart and lung diseases and various types of paralysis and muscle weaknesses, such as strokes and multiple sclerosis. It is also important in amputations, fractures and other injuries, and other orthopedic conditions. With the aid of physical therapy, a disabled person may lead a constructive and creative life.

Aids in physical therapy. Many kinds of equipment, exercises, and self-help devices are used to help people with disabilities. Radiant heat lamps, electric heating pads, diathermy, hydrotherapy, and paraffin baths are used to apply heat. Heat relieves pain, improves circulation, and relaxes muscles. Cold, when used soon after injury, lessens pain, hemorrhage, and swelling. Ultraviolet radiation attacks germs and helps heal certain skin disorders. Ultrasound treats inflammatory conditions of joints, muscles, and nerves, and painful amputation stumps.

Exercise helps to maintain and improve body function and posture. It increases muscle tone, strength, and endurance. Some exercises can be performed by the patient alone. For others, the patient might need the help of the therapist. Often mechanical devices, such as parallel bars, stationary bicycles, pulleys, weights, and dumbbells, are used. Self-help devices, such as splints, braces, crutches, and wheelchairs, help disabled people perform daily activities. Physical therapists train people to use these devices and to develop confidence in accomplishing daily tasks.

Careers in physical therapy. Men and women who want to be physical therapists can choose one of three kinds of educational programs. One program leads to a bachelor's degree in physical therapy. The other two programs are for people who already have a bachelor's degree in some other field. One of these programs involves 12 to 18 months of study leading to a certificate in physical therapy. The other program leads to an entry-level master's degree in physical therapy. Physical therapy programs include courses in anatomy, clinical medicine, physiology, psychology, therapeutic exercise, and the use of physical and electrical equipment.

Physical therapists work in such places as clinics, hospitals, schools for disabled individuals, private offices, academic institutions, home health agencies, and nursing homes. In the United States, physical therapists must be licensed before they may practice.

The American Physical Therapy Association is a national organization for physical therapists. It publishes the professional journal, *Physical Therapy,* and other informational material, such as *Careers in Physical Therapy.* Headquarters are in Alexandria, Virginia.

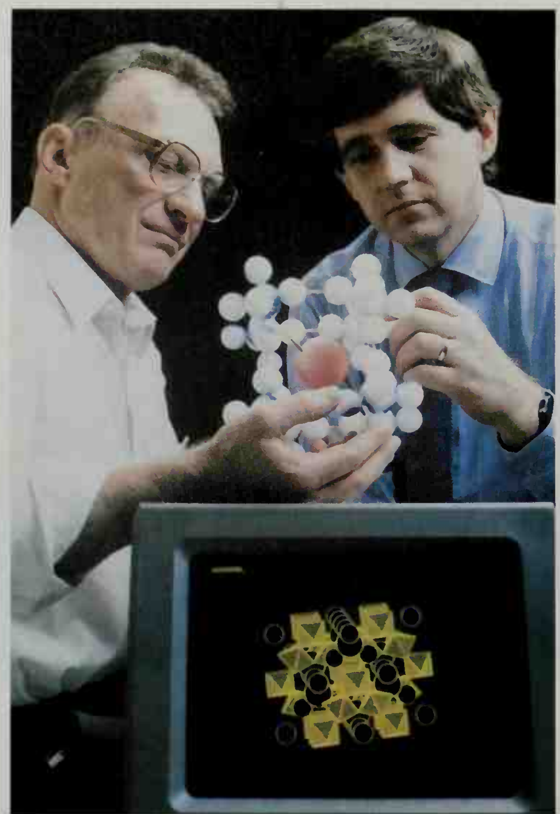
Critically reviewed by the American Physical Therapy Association

See also **Bath** (Medical bathing); **Diathermy**; **Hydrotherapy**.

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Physician. See Medicine.





Boeing Aerospace Company

Studying atomic structure to find new superconductors



Fen

Scanning the tracks of subatomic particles



Sandia National Labora

Developing protective coatings for metals

Research in physics explores the structure and behavior of matter and attempts to answer questions about energy. The work of physicists includes developing theories, performing experiments, and improving manufacturing processes and products.

Physics

Physics is the science devoted to the study of matter and energy. Physicists try to understand what matter is and why it behaves the way it does. They seek to learn how energy is produced, how it travels from place to place, and how it can be controlled. Physicists are also interested in how matter and energy are related to each other and how they affect each other over time and through space.

The word *physics* comes from a Greek word meaning *natural things*. Knowledge obtained from the study of physics is important in other sciences, including astronomy, biology, chemistry, and geology. There is also a close connection between physics and practical developments in engineering, medicine, and technology. For example, engineers design automobiles and airplanes according to certain principles of physics. Laws and theories of physics have enabled engineers and scientists to put satellites into orbit and to receive information from space probes that travel to distant regions of the solar system. Research in physics has led to the use o radioactive materials in the study, diagnosis, and trea ment of certain diseases. In addition, theories and pri ciples of physics explain the operation of many mode home conveniences, from vacuum cleaners to video tape recorders.

James Trefil, the contributor of this article, is the Clarence J. Robinson Professor of Physics at George Mason University.

What physicists study

Physicists try to answer basic questions about the world, how it is put together, and how it changes. So physicists, called *experimental physicists,* perform ca fully designed experiments and then compare their r sults to what was predicted to happen. Such predictio come from laws and theories developed by another group of physicists, called *theoretical physicists.* Thes laws and theories are almost always expressed in the language of mathematics, a basic tool of physics.

The subjects studied by physicists consist of two broad categories, *classical physics* and *modern phys* These two categories differ primarily in emphasis. Cl sical physics deals with questions regarding motion energy. It includes five important areas: (1) mechanics heat, (3) sound, (4) electricity and magnetism, and (5) light. Modern physics concentrates on scientific beli

ɔut the basic structure of the material world. Its major ds include (1) atomic, molecular, and electron ysics; (2) nuclear physics; (3) particle physics; (4) solid-e physics; and (5) fluid and plasma physics.

Mechanics is the study of the effects of forces on dies at rest or in motion. For example, it describes v force acts upon an object to produce acceleration. mechanics of bodies that undergo a change in mo-n because of forces acting upon them is called *dy-mics.* The mechanics of bodies at rest or in motion at onstant speed and in a constant direction is called *tics.* One branch of mechanics, known as *fluid me-nics,* deals with the behavior of liquids and gases. nciples of mechanics are used in describing such es of motion as planetary orbits and the paths of oth-moving objects. They are also important to designers bridges and other structures, containers, roads, and ious kinds of vehicles. See **Mechanics; Dynamics; tics.**

Heat. The study of heat is called *thermodynamics.* It olves investigating how heat is produced, how it is nsmitted from one place to another, how it changes tter, and how it is stored. Heat energy can be trans-med into other kinds of energy, and other kinds of ergy can be transformed into heat energy. For exam-, when coal is burned, the chemical energy that ds its molecules is partially transformed into heat. ermodynamics also includes *cryogenics,* the study of terial at very low temperatures. Principles of thermo-namics are essential for understanding all types of t engines, as well as refrigerators and freezers. See **at; Thermodynamics.**

Sound. The study of sound is called *acoustics.* Sound nsists of vibrations that are produced by an object l which travel through a medium, such as air, water, he walls of a building. Understanding sound is im-tant for designing auditoriums, hearing aids, tape orders, phonographs, and speakers. The study of nd also includes *ultrasonics,* which deals with vibra-ns that have frequencies too high for human beings near. See **Acoustics; Sound.**

Electricity and magnetism are so closely related t scientists often refer to the two of them together as *ctromagnetism.* The motion of electric charges can duce magnetic effects, and magnetic forces can produce electrical effects. A combination of these effects produces *electromagnetic radiation,* which includes visible light, radio waves, and X rays. Knowledge of this relationship has led to the development of huge electric generators and many electronic devices. See **Electricity; Electromagnetism; Electronics; Magnetism.**

Light. The study of light is called *optics.* Optics has two major branches, *physical optics* and *geometrical optics.* In physical optics, physicists study the nature of light and the physical processes by which it is *emitted* (given off) from bodies and transmitted from place to place. Geometrical optics is the study of how light travels, and how the direction of travel is affected by different materials. It is important in understanding the lenses and mirrors which are used in telescopes, microscopes, and eyeglasses. See **Light; Optics.**

Atomic, molecular, and electron physics are concerned with understanding the structures of molecules and atoms. In particular, these fields of physics concentrate on the behavior, arrangement, motion, and energy states of the electrons that orbit atomic nuclei. Studies in atomic, molecular, and electron physics have revealed much about the structure of matter. For example, scientists have determined that substances differ from one another in the arrangement of the atoms of their molecules. Because of this difference, the way that each substance absorbs and emits electromagnetic energy is unique. As a result, scientists are able to identify a substance on the basis of its electromagnetic activity alone. This method of identification has important applications in medicine and in certain industrial situations where minute amounts of a material are involved. See **Atom; Electron; Molecule.**

Nuclear physics involves the study of the structure and properties of the atomic nucleus. It focuses on radioactivity, fission, and fusion. *Radioactivity* is the process by which certain nuclei spontaneously give off high-energy particles or rays. Radioactive materials are used to treat cancer and diagnose illnesses, and to trace chemical and physical processes. *Fission* is the process in which an atomic nucleus splits into two nearly equal parts, releasing a huge amount of energy. It provides the energy for atomic bombs and nuclear reactors. *Fusion* is the process in which the nuclei of two atoms join together to form the nucleus of a heavier element. It oc-

jor branches of physics

ustics studies the production and properties of sound.
mic physics examines the structure, properties, and behav- of the atom.
physics applies the tools and techniques of physics to the y of living things and life processes.
ogenics is the study of extremely low temperatures.
trodynamics analyzes the relationship between electrical magnetic forces.
d physics deals with the behavior and movement of liquids gases.
physics is the study of the earth and its atmosphere and rs by means of the principles of physics.
lth physics involves the protection of people who work or near radiation.
hematical physics is the study of mathematical systems stand for physical phenomena.
hanics deals with the behavior of objects and systems in onse to various forces.
Molecular physics examines the structure, properties, and behavior of molecules.
Nuclear physics is concerned with the structure and properties of the atomic nucleus, and with nuclear reactions and their applications.
Optics is the study of the nature and behavior of light.
Particle physics, also called *high-energy physics,* analyzes the behavior and properties of elementary particles.
Plasma physics is concerned with the study of highly *ionized* gases—that is, gases that have been separated into positively and negatively charged particles.
Quantum physics includes various areas of study based on *quantum theory,* which deals with matter and electromagnetic radiation, and the interactions between them.
Solid-state physics, also called *condensed-matter physics,* examines the physical properties of solid materials.
Thermodynamics is the study of heat and other forms of energy, and of the conversion of energy from one form to another.

curs primarily with hydrogen and other light elements. Fusion, which releases more energy than does fission, produces the energy of the sun and other stars. Fusion also powers the hydrogen bomb. See **Nuclear physics.**

Particle physics. Physicists have discovered that the protons, neutrons, and other particles within atomic nuclei are formed of still more elementary particles called *quarks.* Particle physicists conduct research by using devices called *particle accelerators.* These devices can raise subatomic particles to very high speeds. When these particles have reached speeds very close to the speed of light, they are allowed to collide with ordinary matter. Physicists then study the fragments that result from the collisions and measure their energy. In this way, they hope to understand how protons, neutrons, and other subatomic particles behave. See **Particle accelerator.**

Solid-state physics, also called *condensed-matter physics.* Solids may be classified according to how the electrons and nuclei of the different atoms that make them up interact with each other. Physicists who study solids are interested in how the properties of these materials are affected by such factors as temperature and pressure. For example, at extremely low temperatures, some solids lose all electrical resistance, thereby becoming *superconductors.* Research on the electronic structure of solids is especially important in understanding the behavior of *semiconductors,* which serve as the basis of modern electronic devices. See **Semiconductor; Solid-state physics; Superconductivity.**

Fluid and plasma physics. The modern physics of fluids is built on the principles of classical fluid mechanics. Understanding the behavior and movement of fluids is important for the design and construction of automobiles, ships, airplanes, and rockets, as well as for the study of weather. Plasma physics concerns the study of substances called *plasmas.* When enough energy is introduced into a gas, the gas becomes *ionized* (separated into positively and negatively charged particles). The result is a plasma. Plasmas are used in neon lights and fluorescent lamps. Physicists are studying how plasmas might be controlled and used to produce fusion energy to generate electric power. See **Fluid mechanics; Hydraulics; Plasma.**

History

Through the centuries, physics has been closely linked to developments in technology and to advances in mathematics, astronomy, and other sciences. The use of the word *physics* in its current sense was first recorded in the 1700's.

The beginnings of physics date back to prehistoric times. Stonehenge and the other huge rock structures prehistoric people built indicate that they had some knowledge of mechanics. Such knowledge would have been necessary for them to transport these rocks and to place them on top of one another. In addition, there is strong evidence that prehistoric people may have used these rock structures to mark significant moments in the seasonal cycle of the sun and moon.

The first people to leave written records of their discoveries and inventions were the Sumerians, Babylonians, and Egyptians. By around 3000 B.C., the Sumerians had developed a number system, and they used algebraic formulas for following and predicting movement of the stars, sun, moon, and planets. Similar developments occurred in Egypt and Babylonia. The Egyptians also developed practical geometric techniques for use in construction and land surveying.

The Greeks appear to have been the first people to develop general theoretical systems of mathematics ar natural science. Beginning about 600 B.C., they developed a general understanding of the principles of geometry. The Greek mathematician Euclid organized these principles into a unified system about 300 B.C.

The Greeks were keen observers of the physical world. In the 300's B.C., the philosopher Aristotle provi ed proofs, based on physical evidence, of the spherica shape of the earth. In the 200's B.C., the astronomer Eratosthenes calculated the circumference of the earth, and Aristarchus, another astronomer, estimated the re tive distances to the moon and sun. Also during the 200's B.C., the mathematician and inventor Archimedes discovered several basic scientific principles and deve oped ways of calculating areas and volumes.

In the A.D. 100's, Ptolemy, an astronomer in Alexandria, Egypt, developed a model for predicting the posi tions of the sun, moon, stars, and planets. Like Aristotle and other Greek philosophers, Ptolemy viewed the ea as the center of the universe. Ptolemy's system served a guide for predicting the motion of the heavenly bodi for nearly 1,500 years.

The Middle Ages began in about the 400's with the fall of the Roman Empire. At that time, records of Gree scientific discoveries were lost to western Europe. Fro about 400 to 1000, most educated people in Western E rope felt that religion, rather than scientific investigatio should provide the answers to questions about the un verse.

Much of the Greek written tradition in science was preserved during the early Middle Ages by people in the Middle East. These people translated many of the Greek works into Arabic. Arabic scholars wrote commentaries on these texts, made astronomical observations, and performed experiments in optics and mechanics.

Trade between the Arab cultures of the East and the Christian cultures of the West increased during the 1000's. As a result, Greek scientific documents were reintroduced into the West, this time as translations from Arabic to Latin. At first, the science of Aristotle ar other Greeks was rejected by the church. But during tl 1200's, Saint Albertus Magnus, Saint Thomas Aquinas, and other religious scholars successfully reconciled Aristotelian physical science with church principles.

During the 1100's and 1200's, there was also increas ing interest in scientific observation and experiments. For example, various writings, including those of the English scholars Robert Grosseteste and Roger Bacon proposed effective methods for scientific research.

Practical inventions in agriculture and other fields a sparked scientific inquiry in Europe during the Middle Ages. In China and other Asian countries, scientific act ity and invention flourished during this period. Howev er, unlike in the West, science and technology had litt influence on each other.

The Renaissance is the name given to the period i Europe that extended from about the early 1300's to

ut 1600. It was a time of social, economic, political, intellectual excitement that produced many new ap-aches in both the arts and the sciences.

n the 1300's, at Oxford University and the University aris, such scholars as Richard Swineshead and ole Oresme investigated the problem of the descrip- of motion. During the 1400's and 1500's, the famous an painter and inventor Leonardo da Vinci also con-ted studies of motion and hydraulics.

n 1543, the Polish astronomer Nicolaus Copernicus lished a revolutionary astronomical system in which placed the sun—instead of the earth—at the center of universe. Copernicus proposed that the earth was of the planets, all of which orbited the sun. At the e, almost no one accepted his point of view. Many holic and Protestant leaders felt that his system was onflict with their religious beliefs. There were also ous scientific objections to the system. Acceptance he Copernican system required a complete rethink-of the whole basis of physical science. Such a re-king did in fact occur over the next 150 years, pri-ily through the work of such major figures as leo, Johannes Kepler, and Rene Descartes.

eginning in 1609, the Italian astronomer and physi-Galileo built telescopes for observing the heavens. ile none of Galileo's observations with his telescopes ved the Copernican system, they did question tradi-al views. Galileo also perfected the idea of the labo-ry experiment in his study of the motion of falling ies. He showed that a person could gain an under-ding of the way objects fall toward the earth by as-ing that, in the absence of disturbing influences, all objects accelerate at the same constant rate.

the early 1600's, the German astronomer and math-tician Johannes Kepler used the observations of oth-to construct a new and accurate model of the solar em. In the mid-1600's, Rene Descartes, a French philosopher and mathematician, challenged the long-standing assumption that an absence of motion was the natural state of all objects. Instead, he proposed that objects have inertia—that is, they maintain whatever their state of motion unless otherwise disturbed.

The work of Galileo, Kepler, and Descartes reflects a change in attitude that occurred during the Renaissance. People came to believe that natural laws governed the physical world, and it was seen as possible to discover those laws through careful measurements carried out, if possible, under controlled laboratory conditions.

Newton. By the 1600's, a great deal of scientific activity was underway. The climax of this increased activity was the publication, in 1687, of *Philosophiae Naturalis Principia Mathematica* (*Mathematical Principles of Natural Philosophy*) by the brilliant English scientist, Sir Isaac Newton. In this work, Newton showed how both the motions of heavenly bodies and the motions of objects on or near the surface of the earth could be explained by four simple laws. These laws were Newton's three laws of motion and his law of universal gravitation.

Newton's laws of motion summarized and extended the work of Galileo and Descartes. His law of universal gravitation explained both Galileo's law of falling bodies and Kepler's laws of planetary motion. To conduct some of his research and calculations, Newton invented calculus, a new form of mathematics. Mathematical scholar Gottfried Wilhelm Leibniz of Germany independently developed calculus about the same time. See **Calculus**.

In addition to his theoretical discoveries, Newton constructed the first reflecting telescope. Using prisms, he performed ingenious experiments on light that led him to propose that white light was a mixture of all colors. In 1704, he published a particle theory of light. This theory competed with another theory of light that had been proposed by the Dutch physicist Christiaan Huygens in 1678, but not published until 1690. Huygens had

ortant dates in physics

s B.C. Aristotle formed theories in many areas of physics.
s B.C. Archimedes proved the law of the lever and discov- laws for the behavior of liquids.
100's Ptolemy pictured the earth as standing still, with the moon, planets, and stars moving in circles around it.
70 Roger Bacon conducted studies in optics.
Nicolaus Copernicus wrote that the earth and planets e in circles around the sun.
00 Galileo discovered important laws in many fields of ics, especially mechanics.
Sir Isaac Newton published his laws of motion.
Christiaan Huygens published a wave theory of light.
Benjamin Thompson, Count Rumford, stated that the mo- of particles in a substance produced heat.
-1803 Thomas Young revived the wave theory of light.
John Dalton first proposed his atomic theory about the ture of matter.
y 1830's Michael Faraday and Joseph Henry independently uced electricity with magnetism.
James P. Joule found that heat and energy are interchange- at a fixed rate.
James Clerk Maxwell published his electromagnetic theo- light.
Wilhelm C. Roentgen discovered X rays.
Antoine Henri Becquerel discovered natural radioactivity.
Marie Curie and her husband, Pierre, discovered the ra- tive element radium.
Max Planck published his quantum theory.
1905 Albert Einstein published his special theory of relativity.
1911-1913 Ernest Rutherford and Niels Bohr proposed "planetary system" models of the atom.
1915 Einstein announced his general theory of relativity.
1924 Louis de Broglie put forth the wave theory of the electron.
1925-1926 Erwin Schrödinger and Werner Heisenberg separately developed systems for organizing quantum physics.
1930 Paul A. M. Dirac predicted the existence of the *positron,* a positively charged electron.
1932 John D. Cockcroft and Ernest T. S. Walton became the first to break down atomic nuclei with accelerated particles.
1938 Otto Hahn and Fritz Strassman achieved fission of the uranium atom.
1942 Enrico Fermi and associates achieved the first controlled nuclear chain reaction.
1947 John Bardeen, Walter H. Brattain, and William Shockley of Bell Telephone Laboratories invented the transistor.
1960 Theodore H. Maiman built the first laser.
1964 Murray Gell-Mann and George Zweig proposed the existence of quarks as fundamental particles.
1974 Burton Richter and Samuel C. C. Ting discovered a type of subatomic particle called the *psi particle* or *J particle.*
1983 Researchers led by Carlo Rubbia discovered two types of subatomic particles—the W particle and the Z particle.
1995 Fermi National Accelerator Laboratory announced the discovery of a type of subatomic particle known as the *top quark.*
2000 Fermi researchers announced the first direct detection of a kind of subatomic particle called the *tau-neutrino.*

argued that light traveled in the form of waves, rather than particles. But during the 1700's, most scientists accepted Newton's particle theory.

Developments in the 1800's. The Industrial Revolution, which had begun in Great Britain in the 1700's, led to the production of scientific instruments that were extremely accurate for their time and which enabled scientists to perform more complicated experiments. As scientific research grew more complex, people began specializing in more narrowly defined areas of study. Three areas of particular interest in the 1800's were heat and energy, light, and electricity and magnetism.

Developments in the study of heat and energy. At the beginning of the 1800's, it was widely believed that heat existed in the form of a fluid, called *caloric.* But by the middle of the century, scientists had come to view heat not as a fluid, but as a form of energy. That is, they had learned that heat is able to do work. In the 1840's, James Joule, an English physicist, showed how to calculate how much work a given quantity of heat could do. About the same time, a number of physicists, including Lord Kelvin of Great Britain and Hermann von Helmholtz of Germany, independently proposed the law of conservation of energy. This law states that energy cannot be created or destroyed, only transformed from one kind to another. See **Energy** (The conservation of energy).

By the mid-1800's, heat energy also came to be interpreted as the mechanical movement of the atoms of which everything was made. This interpretation was based on the atomic theory proposed in 1803 by John Dalton, an English chemist.

Developments in the study of light. From 1800 to 1803, the English physicist Thomas Young published a series of papers, based on experiments he had done, that revived the theory that light existed in the form of waves. From about 1815 to 1819, Augustin Fresnel, a French physicist, provided still more evidence. By 1850, the wave theory of light was almost universally accepted, replacing Newton's particle theory.

The wave theory of light led physicists to propose tl existence of a material called the *ether.* They reasoned that if light traveled in waves and could travel through vacuum, there had to be some medium present to sup port the waves. They concluded that all space, includin vacuums, was filled with the ether. They interpreted light energy as simply the vibration of the ether, in the form of waves. See **Ether**.

Developments in the study of electricity and magnetism. In 1800, Count Alessandro Volta of Italy announced his invention of the first electric battery. This invention opened the way for new methods of studyin electrical effects. About 1820, two physicists, André Marie Ampère of France and Hans Christian Oersted o Denmark, showed that electricity and magnetism were related. In the early 1830's, the English physicist Micha Faraday and the American physicist Joseph Henry independently demonstrated how to produce electricity in changing magnetic field. Their demonstrations showe that mechanical energy could be converted into electr cal energy and suggested the principles behind the ge erator and the motor.

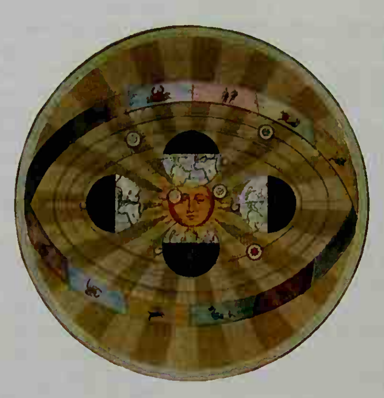
In the 1860's, the Scottish physicist and mathematici James Clerk Maxwell developed a theory that interpreted visible light as the movement of electromagnet waves. Maxwell predicted the possible existence of sir ilar electromagnetic waves that were invisible. Heinricl Hertz, a German physicist, detected such invisible *radi waves* in the late 1880's. Hertz's discovery eventually le to the development of radio, radar, and television. But also suggested that light, electricity, and magnetism were related. All three were viewed as resulting from waves in the ether. Such waves are sometimes referre to as *electromagnetic radiation.*

The beginning of modern physics. Near the end the 1800's, many physicists were convinced that the work of physics was nearly over. They believed that almost all the laws governing the physical universe had been discovered. Some of them believed that all physi



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Archimedes, a Greek inventor, discovered several basic principles of physics during the 200's B.C. He also developed a number of measuring techniques.



Culver

The astronomical system proposed by Polish astronomer Nicolaus Copernicus in 1543 placed the sun, not the earth, at the center of the universe.



Granger Collec

Galileo in Italy discovered the law of fa ing bodies and the law of the pendulur In 1609, he began building telescopes t observe the heavens.

ıl laws would one day be expressed in a few simple ˌuations.

A few problems remained to be solved, however. ne such problem involved determining the source of ectromagnetic radiation. Scientists knew that under e right conditions, each chemical element radiates a ıique combination of visible, infrared, and ultraviolet ȷht, called *line spectra.* At the time, the atom was condered to be the most fundamental unit of matter in the ıiverse. But to some physicists, the line spectra pheɔmenon suggested that the atom might itself be comɔsed of still more fundamental units.

The dream of explaining all physical phenomena with ıe small set of basic laws was not realized. Instead, varus discoveries began to reveal that such phenomena ere more complex than scientists had thought. In 1895, r example, Wilhelm Roentgen of Germany discovered rays. In 1896, the French physicist Antoine Henri Becıerel discovered *natural radioactivity,* the spontaneous ıission of radiation from atoms. In 1897, the English ıysicist Joseph John Thomson discovered the first subomic particle, later called the *electron.* In 1898, the ench physicists Marie Curie and her husband, Pierre, scovered the radioactive element radium. Such develɔments signaled that, rather than being nearly over, e work of physics had only begun.

Quantum theory. The early 1900's brought revoluɔnary developments in physics. Scientists looked for consistencies in the classical physics of Newton and hers, and discovered new interpretations of observed ents.

In 1900, the German physicist Max Planck published s quantum theory of energy transfer to explain the ıectrum of light emitted by certain heated objects. He ated that energy is not given off continuously, but in e form of individual units called *quanta.* In 1905, Albert nstein, the German-born American physicist, proɔsed a new particle, later called the *photon,* as the carər of electromagnetic energy. Einstein said that light, in spite of its wave nature, must be composed of these energy particles.

In 1913, the Danish physicist Niels Bohr explained in terms of quanta how atoms absorb and radiate energy. In 1924, Louis de Broglie, a French physicist, proposed that electrons could also exhibit wave properties. In the mid-1920's, two physicists, Erwin Schrödinger of Austria and Werner Heisenberg of Germany, produced separate, but equivalent, systems for organizing all earlier quantum physics. The combined ideas of Schrödinger and Heisenberg have since been developed as the field of *quantum mechanics.* See **Quantum mechanics.**

Einstein and relativity. During the 1800's, physicists tried unsuccessfully to measure the speed of the earth relative to the ether. According to classical physics, the ether was motionless. In the early 1880's, Hendrik A. Lorentz, a Dutch physicist, explained the failure of these experiments by assuming that the ether was partially dragged along as the earth moved through it. Two American physicists, Albert A. Michelson and Edward W. Morley, developed an instrument that made far more precise measurements than earlier devices. Their experiments helped destroy the ether theory. In 1887, Michelson and Morley demonstrated that the earth's movement around the sun had no effect on the speed of light. Their finding could be understood only by assuming that the ether near the surface of the earth moved at the same speed as the earth. However, this assumption contradicted the results of many other experiments.

The contradiction was not resolved until 1905. That year, Albert Einstein analyzed the measuring process itself and, as a result, proposed his special theory of relativity. The theory begins with two *postulates* (fundamental principles). The first postulate states that for all observers moving uniformly relative to each other, the laws of physics have the same form. The second postulate states that for all observers, the speed of light is *invariant* (has the same value). One conclusion from these postulates is that mass and energy are related. Einstein



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· **Isaac Newton** of England stated laws motion and gravitation during the late ɔ0's. He also demonstrated that white ht is made up of all colors.



UPI/Bettmann Newsphotos

Wilhelm Roentgen of Germany discovered X rays in 1895. The use of X rays helped doctors diagnose illness and injury and revolutionized medicine.



Brown Brothers

Marie Curie of France made many advances in the study of radioactivity. In 1898, she and her husband, Pierre, discovered the radioactive element radium.

expressed this relationship in his famous equation $E = mc^2$. In this equation, E stands for energy, m for mass, and c^2 for the speed of light multiplied by itself.

Einstein also attempted to replace classical gravitational theories with a more exact statement of the laws of gravitation. In 1915, he announced his general theory of relativity, which assumes that the effects of gravity on objects are identical to the effects of nongravitational forces acting on objects. Gravity is no longer viewed as a property of objects interacting with each other, but of objects interacting with space itself. The theory predicted that the path of a light beam will be affected by nearby massive objects. This prediction was confirmed in 1919. The theory also predicted the existence of *gravitational waves* that travel at the speed of light. But these waves have not yet been detected. See **Relativity.**

Uncovering the secrets of the atom. The discovery that atoms have an internal structure prompted physicists to probe further into these tiny units of matter. In England, Ernest Rutherford performed experiments that led to a model of the atom in 1911. In this model, the dense positive charge resided in a small, spherical core called the nucleus, and the electrons traveled around this nucleus. Bohr proposed modifications of the model in 1913. That year, an American, Robert Millikan, reported an accurate measurement of the electron's charge. See **Atom.**

The discovery of other subatomic particles continued after this early work. In 1932, James Chadwick, an English physicist, conducted experiments that suggested that the atomic nucleus was composed of two kinds of particles: positively charged protons and neutral neutrons. In 1935, Hideki Yukawa, a Japanese physicist, proposed that other particles, which he called *mesons,* exist in the atomic nucleus (see **Meson**).

In 1938, two German physicists, Otto Hahn and Fritz Strassman, discovered nuclear fission by splitting uranium atoms. Scientists quickly realized that, as Einstein's formula $E = mc^2$ indicated, fission could liberate huge quantities of energy. In 1942, during World War II, the Italian-born physicist Enrico Fermi and his co-workers at the University of Chicago achieved the first controlled fission chain reaction. In 1945, near the end of the war, American scientists and engineers produced the first bombs that relied on nuclear fission for their explosive power. Two such atomic bombs were dropped on Japan in August 1945. See **Nuclear energy** (The development of nuclear energy); **Nuclear weapon.**

Advances in the mid-1900's. After 1945, the picture of the atom grew more complicated as physicists discovered more and more subatomic particles. In 1955, the American physicists Owen Chamberlain and Emilio Segre discovered the *antiproton* (a negatively charged proton). In 1964, two California Institute of Technology physicists, the American Murray Gell-Mann and Russian-born George Zweig, proposed the existence of *quarks* as fundamental particles. Protons and neutrons are composed of different combinations of quarks. Strong evidence for the existence of the quark resulted from the discovery of the *psi particle,* a type of subatomic particle also called the *J particle,* by the Americans Burton Richter and Samuel C. C. Ting. By 1995, scientists had discovered six types of quarks. Physicists are almost certain that there are no more quarks to discover. See **Antimatter; Psi particle; Quark.**

Research in the mid-1900's also led to important advances in technology. In 1947, American physicists invented the transistor. This tiny device revolutionized the electronics industry. In the early 1960's, researchers in atomic and optical physics produced light-amplifying devices called lasers. Lasers have become valuable tools in such areas as communications, industry, and nuclear energy research. See **Laser; Transistor.**

Physics today. Physics continues to be one of the most active and important sciences. Ongoing research into the nature of matter has led to important discoveries. For example, researchers in West Germany discovered an important elementary particle, the *gluon,* in



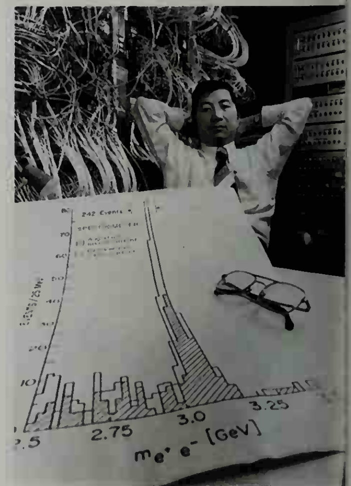
UPI/Bettmann Newsphotos

Albert Einstein proposed the special theory of relativity in 1905. It revised ideas of time and space and provided the basis for releasing the atom's energy.



Hughes Aircraft Company

Theodore H. Maiman of the United States built the first laser, a ruby laser, and first operated it in 1960. A laser amplifies light into a powerful beam.



Brookhaven National Laboratory

Samuel C. C. Ting, *shown here,* and Burton Richter of the United States discovered a new type of subatomic particle—the *psi,* or *J, particle*—in 1974.

1979. Gluons carry the *strong nuclear force.* This force, also called the *strong interaction,* holds quarks together in protons, neutrons, and other particles; and holds protons and neutrons together in atomic nuclei. In 1983, a research team led by Carlo Rubbia of Italy discovered two more subatomic particles—the *W particle* and the *Z particle.* Physicists predict that these particles are a source of the *weak nuclear force,* or the *weak interaction.* This force controls the disintegration of some atomic nuclei—a process at work in radioactivity.

Physicists believe that six kinds of quarks exist. The last of these to be discovered was the *top quark.* Scientists at Fermi National Accelerator Laboratory (Fermilab) near Batavia, Illinois, announced the discovery of this particle in 1995. Physicists also believe that there are three types of *neutrinos,* particles that interact with other particles by means of the weak nuclear interaction. The last kind of neutrino to be directly detected is known as the *tau-neutrino.* In 2000, researchers at Fermilab announced that they had made the first direct detection of tau-neutrinos.

There may be an underlying unity among three of the basic forces of the universe: the strong force, the weak force, and the electromagnetic force that holds electrons to the nucleus. Theories that attempt to establish this underlying unity are referred to as *grand unified theories* (GUT's).

Physics also continues to make important contributions to technology. For example, advances in electronics resulted in the development of extremely sophisticated computers. Lasers and *optical fibers* (glass or plastic filaments that carry light) led to improvements in communication systems and medical technology (see **Fiber optics**). Physicists began developing ceramiclike materials that can act as superconductors at much higher temperatures than the superconductors of the past.

Careers in physics

Education and training. A person who plans to pursue physics as a career should take science and mathematics courses in high school. The formal training of physicists begins in college. Physics students must learn calculus, modern algebra, and other forms of higher mathematics. They also take basic courses in chemistry. After a year or two of introductory courses, physics majors begin to specialize, taking more advanced courses in the various subfields of physics. Many of these advanced courses include intensive laboratory work.

Most physics majors continue their education beyond the bachelor's degree. A majority pursue doctor's degrees.

Employment. More than half the physicists in the United States are engaged in research and development activities. Many industries employ physicists in their research departments. These people often work in *applied physics,* which generally involves improving manufacturing processes or products. Many physicists are employed by colleges and universities. They generally divide their time between teaching classes and performing research.

Today, physics research often requires the use of highly specialized and expensive instruments and equipment, such as high-energy particle accelerators. In the United States, special laboratories with this type of equipment are funded by government agencies (see **National laboratory**). An association of European nations now known as the European Organization for Nuclear Research (CERN), established the world's largest particle physics research center, near Geneva, Switzerland. Although the U.S. national laboratories and the CERN laboratories have their own staffs, physicists throughout the world may apply to use the facilities in their research.

James Trefil

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Mössbauer, Rudolf L.
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Atomic, nuclear, and particle physics

Alpha particle
Antimatter
Atom
Baryon
Beta particle
Boson
Cosmic rays
Crookes tube
Electron
Fermion
Fission
Fusion
Gamma rays
Gluon
Hadron
Higgs boson
Ion
Irradiation
Isotope
Lepton
Meson
Molecule
Muon
Neutron
Nuclear energy
Nuclear physics
Nuclear weapon
Parity
Particle accelerator
Particle detector
Photon
Proton
Psi particle
Quark
Radiation
String theory
Subatomic particle
Transmutation of elements
X rays

Electricity

See the **Electricity** article and its list of *Related articles.*

Electronics

See the **Electronics** article and its list of *Related articles.* See also the following articles:

Electric field
Frequency modulation
Geiger counter
Kilohertz
Mass spectroscopy
Night vision systems
Remote control
Short waves
Transducer
Van de Graaff generator
Very high frequency waves

Heat

See the **Heat** article and its list of *Related articles.* See also the following articles:

Absolute zero
Distillation
Freezing point
Melting point
Sublimation
Superconductivity

Light

See the **Light** article and its list of *Related articles.*

Magnetism

See the **Magnetism** article and its list of *Related articles.*

Mechanics

Aerodynamics
Adhesion
Antigravity
Ballistics
Bernoulli's principle
Capillarity
Cohesion
Dyne
Efficiency
Falling bodies, Law of
Fluid mechanics
Foot-pound
Force
Friction
Gas
Gravity, Center of
Horsepower
Hydraulics
Inclined plane
Inertia
Lever
Liquid
Manometer
Mechanics
Momentum
Motion
Osmosis
Pascal's Law
Pendulum
Power
Pressure
Pulley
Screw
Siphon
Superfluid
Surface tension
Vacuum
Velocity
Viscosity
Wedge
Work

Sound

See the **Sound** article and its list of *Related articles.*

Other related articles

Astronomy
Biophysics
Dark matter
Geophysics
Gravitation
Interference
Matter
Quantum field theory
Quantum mechanics
Relativity
Solar energy
Solar wind
Solid-state physics
Waves

Outline

I. What physicists study
- A. Mechanics
- B. Heat
- C. Sound
- D. Electricity and magnetism
- E. Light
- F. Atomic, molecular, and electron physics
- G. Nuclear physics
- H. Particle physics
- I. Solid-state physics
- J. Fluid and plasma physics

II. History

III. Careers in physics
- A. Education and training
- B. Employment

Questions

What is the difference between the work of a theoretical phys cist and that of an experimental physicist?
What did Galileo demonstrate in his study of the motion of falling bodies?
When did physicists achieve the first controlled fission chain reaction?
What are some examples of developments in engineering anc technology that involve the principles of physics?
What are grand unified theories?
What are the two postulates of Einstein's special theory of relativity?
What technological advances resulted from physics research during the mid-1900's? How have the advances of this perio been important?
How did Arabic scholars contribute to the development of physics during the Middle Ages?
What are quanta? Who first proposed the idea of quanta?
What did Michelson and Morley demonstrate in their 1887 experiment?

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Hewitt, Paul G. Conceptual Physics. 9th ed. Addison-Wesley, 2001.
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Suplee, Curt. *Physics in the 20th Century.* Abrams, 1999.

Physiocrats were a group of French economists wh lived during the mid-1700's. They made important con tributions to the development of economics as a socia science. The physiocrats' broad outlook and use of the scientific method made them the first modern thinkers in economics.

The physiocrats believed that land was the single source of wealth. They thought that only in agriculture could the value of the products exceed the value of th materials used for production. Physiocrats regarded in dustry and trade as necessary occupations, but ones t did not increase wealth in the same way as did agricul ture. Trade and commerce, they felt, changed only the form or location of wealth. These beliefs led the physiocrats to oppose the mercantile system of tariffs and trade restrictions. Mercantilists thought that a government should regulate economic activities in order to e sure that the country exports more goods than it imports (see **Mercantilism**). In place of tariffs, the physiocrats proposed a single land tax. They supporte *laissez faire* (freedom from government regulation).

François Quesnay was the leader and most importa thinker of the physiocrats. He devised the *Tableau Éco nomique,* a chart of the economy. This was the first attempt to picture a nation's economy as an interrelated series of institutions through which capital moves in a continuous cycle. Another physiocrat, Pierre Samuel

du Pont de Nemours, later emigrated from France to the United States, where his descendants founded the Du Pont industrial empire. Leonard S. Silk

See also **Du Pont de Nemours, Pierre Samuel; Quesnay, François.**

Physiology is the study of how living things function. Scientists who study physiology are called *physiologists.* Their studies range from the most basic unit of organisms, the cell, to complex organs and organ systems, such as the brain and digestive system.

Physiologists study how different parts or organs of an organism work together to achieve a particular function. In people, for example, the digestion of food involves the action of hormones and other chemicals produced by the stomach, liver, and pancreas. Muscle contraction occurs through the action of chemical messengers produced by nerves that supply the muscle.

By learning how the body functions normally, physiologists and doctors are better able to understand what happens when organs function abnormally. They can then prescribe the best treatment. For example, the thyroid gland uses iodine to make *thyroxine,* a hormone that affects the entire body. If iodine is too low in the diet, the thyroid gland expands, forming a large mass called a *goiter.* This condition can be corrected by including iodine in the diet (see **Goiter**). Studies of the circulatory and nervous systems have helped doctors understand and treat heart disease, stroke, and high blood pressure. Cell physiologists, who study the properties of individual cells, hope to learn what causes some cells to become cancerous. P. Landis Keyes

See also **Bernard, Claude; Harvey, William.**

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Phytoplankton. See **Ocean** (The plankton; The food cycle).

Pi, *py,* is the ratio of the circumference of a circle to its diameter. This ratio is the same for every circle and is approximately 3.14159. It is represented by the Greek letter π (pi).

Pi is used in a number of mathematical calculations. For example, the circumference *(c)* of a circle can be determined by multiplying the diameter *(d)* of the circle by pi: $c = \pi d$. Pi is also used to calculate the areas of circles and the volumes of spheres and cones. The area *(A)* of a circle is given by the formula $A = \pi r^2$, where r is the radius. In addition, a number of formulas that describe such physical phenomena as the motion of a pendulum or the vibration of a string include pi as well.

Pi is an *irrational number.* An irrational number cannot be written as a simple fraction or as a decimal with a *finite* (limited) number of decimal places. Mathematicians have used computers to calculate pi to millions of decimal places. Thomas P. Carpenter

See also **Circle** (The use of pi; History).

Piaf, *PEE ahf,* **Edith** (1915-1963), was a French singer whose frail appearance, difficult life, and haunting singing style made her a legend in France.

Piaf's real name was Edith Giovanna Gassion. Her father was a noted acrobat. Piaf's mother deserted her as an infant. The girl went blind for a short time about the age of 4, probably as a result of an infection. She received little formal education. As a child, Piaf traveled with her father as a singer and his assistant. At the age of about 15, she began singing on the streets and in cheap cabarets. One proprietor named her "Piaf," which was Parisian slang for "little sparrow." The nickname suited her delicate, childlike appearance. She was only 4 feet 10 inches (147 centimeters) tall and weighed about 90 pounds (41 kilograms).



UPI/Corbis-Bettmann

Edith Piaf

Tragedy marked Piaf's personal life. Her only child died in infancy. A man she loved, French boxer Marcel Cerdan, was killed in a plane crash. Such misfortunes were reflected in the sad and nostalgic ballads she sang, some of which she composed. Her most famous song was "La vie en rose." Gerald Bordman

Piaget, *PEE uh ZHAY,* **Jean,** *zhan* (1896-1980), a Swiss psychologist, won fame for his studies of the thought processes of children. He and his associates published more than 30 volumes on this subject.

Piaget believed children pass through four periods of mental development. During the *sensorimotor period,* they obtain a basic knowledge of objects through their senses. This period lasts until about age 2. During the *preoperational period,* from about 2 to 7, children develop such skills as language and drawing ability. In the *period of concrete operations,* from about 7 to 11, they begin to think logically. For example, they learn to organize their knowledge, classify objects, and do thought problems. The *period of formal operations* lasts from about 11 to 15. At this time, children begin to reason realistically about the future and to deal with *abstractions.* Abstractions are ideas about qualities and characteristics viewed apart from the objects that have them.

Piaget was born in Neuchâtel. When he was 10, he published a scientific article on an albino sparrow. He published articles on mollusks at 15. He received a doctor's degree in the natural sciences in 1918 and then studied psychology. In 1921, Piaget began to do research in child psychology at the Institute J.-J. Rousseau in Geneva. He served as its codirector from 1933 to 1971 and as director of the International Bureau of Education from 1929 to 1967. Piaget was a professor of psychology at the University of Geneva from 1929 until his death. In 1955, Piaget founded the Center for the Study of Genetic Epistemology, an organization that studies learning processes. Robert C. Weyant

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Piano is a keyboard musical instrument in which sounds are made by strings struck by small padded hammers. A piano produces a greater range of musical sounds than most other instruments. On a piano, a musi-



Chicago Musical College (WORLD BOOK photo)
Grand pianos, such as the one shown above, are the largest and most expensive pianos. Performers use them in concerts.

cian can play melody and harmony at the same time. A pianist also can play an extraordinary variety of loud and soft notes with great speed.

A musician plays a piano by striking keys of the keyboard. The keys operate levers that move the padded hammers. The hammers strike tightly stretched metal strings, which are mounted on a frame. These metal strings vibrate and therefore produce tones. The loudness of a tone depends on how hard the pianist strikes the keys.

The piano is important in many kinds of music. Most classical composers have written music for the piano as a solo instrument and in combination with other instruments or with singing. The piano is also used in jazz, rock, and other kinds of music.

Parts of a piano

A standard piano has seven main parts: (1) strings, (2) keyboard, (3) action, (4) pedals, (5) frame, (6) soundboard, and (7) case. The case covers the strings, action, frame, and soundboard. The keyboard and pedals are attached to the outside of the case.

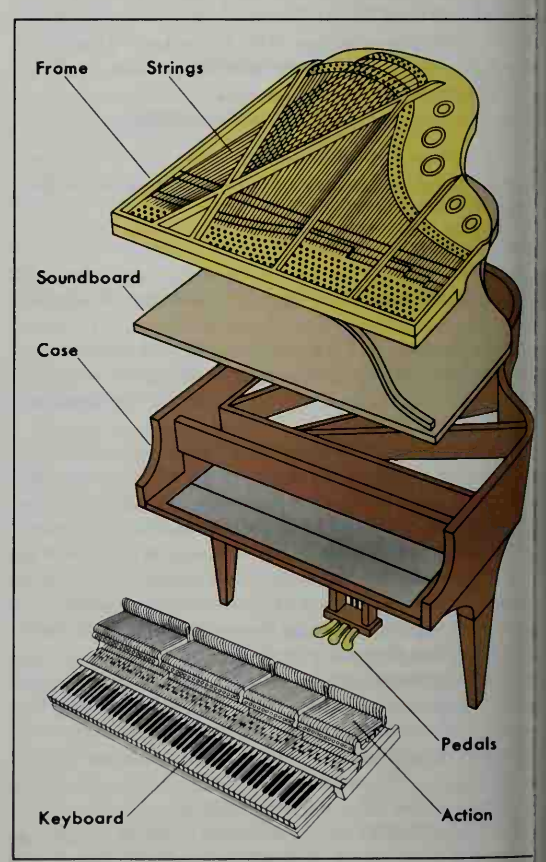
The strings. In almost all pianos, the strings are made of steel. Most pianos have more than 220 strings, each tuned to one of 88 pitches. The strings vary in length from 6 to 80 inches (15 to 200 centimeters). They are arranged in ascending order from left to right by *semitones,* or *half steps.* The longest strings are lowest in pitch and form the *bass section,* which occupies the left side of the piano. The shortest strings are highest in pitch and form the *treble section,* which occupies the right.

The pitch of a tone is determined mainly by the length of the strings. However, it also depends on the number, thickness, and *tension* (tightness) of the strings that produce each tone. About 58 tones, called *unisons,* have three strings each, and almost all the rest have two strings. In most cases, heavy strings are used for the low tones, and light strings for the high ones. The tension of the strings is adjusted when tuning a piano. Loosening string lowers the pitch, and tightening a string raises i

The keyboard. A standard piano keyboard has 88 keys. Like the strings, the keys are arranged according to pitch, in ascending order from left to right. On mos pianos, 36 keys are black, and 52 are white. The black keys are shorter and thicker than the white ones. Mos pianos have plastic keys. But on some pianos, the whi keys are made of ivory, and the black ones of ebony.

The action is an elaborate system of mechanical de vices that transmit motion from the keyboard to the strings. The pianist starts the action by striking a key, which causes a system of levers to move a hammer. Tl hammer is made of wood and covered with a special kind of felt. The hammer strikes a string, which vibrate and so produces a tone. When the player releases the key, a device called the *damper* presses against the string and stops its movement. If the pianist holds the key down, the damper remains off the string, allowing to vibrate and produce a tone. A piano's action consis of about 4,000 parts, most of which are made of wood

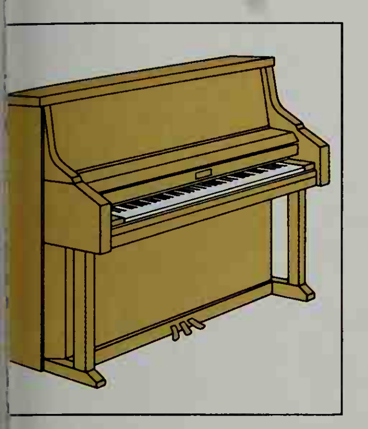
The pedals are located below the keyboard at the bottom of the piano. They are used to vary the quality tones played. The pianist operates the pedals with his her feet. Most pianos have a *damper pedal* on the rigl and a *soft pedal* on the left. The damper pedal lifts all



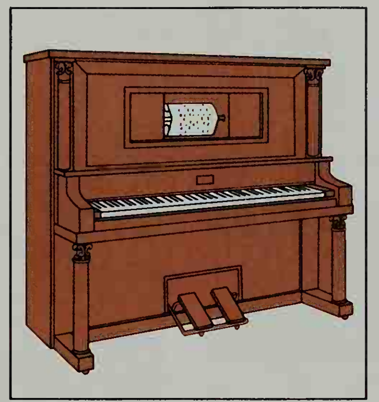
WORLD BOOK drawing by Zorica Da
A standard piano consists of seven main parts. A wooden ca encloses the frame, strings, soundboard, and action. The keyboard and pedals are attached to the outside of the case.

/ajor kinds ıf pianos Besides grand pianos, the main kinds of pianos are upright, player, and electronic pianos. Upright pianos are popular in homes due to their small size. Player pianos produce music by means of a moving role of punctured paper. Electronic pianos produce music electronically.

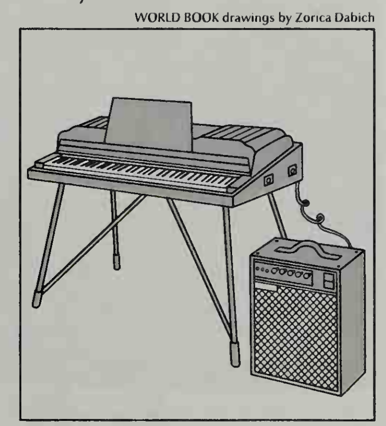
WORLD BOOK drawings by Zorica Dabich



pright piano



Player piano



Electronic piano

ıe dampers, allowing the strings that are struck to vi-rate freely. The soft pedal shifts the hammers, which e arranged in a row. As a result, each hammer strikes ıe less string than it normally does, which softens and ghtens the tone. Some pianos also have a *sostenuto edal.* This pedal lifts the dampers from strings selected / the player.

The frame. A piano requires a strong frame to sup-ort the tremendous tension created by the stretched rings. The frame is made of cast iron. It withstands the rain of 220 strings exerting a total pull of from 35,000 45,000 pounds (15,900 to 20,400 kilograms).

The soundboard is a thin sheet of wood that helps inforce the sound created by the vibrating strings in a ano. The soundboard lies just below the strings and is ade of a light wood, generally spruce. The wood vi-ates with the strings, intensifying the sounds.

The case. Most pianos have a wooden case, which vers the strings, action, frame, and soundboard. The se must be strong enough to support the weight of e piano.

Kinds of pianos

There are four basic kinds of pianos: (1) grand pianos, upright pianos, (3) player pianos, and (4) electronic pi-os. The four types vary in size and construction and e used for different purposes.

Grand pianos are mounted on legs, and their strings d soundboard are parallel to the floor. The *concert and* is the largest and most expensive piano. It meas-es about 9 feet (2.7 meters) long and is used in concert lls. The *parlor grand* and the *baby grand* measure be-een 5 and 6 feet (1.5 and 1.8 meters) long and are suit-le for homes.

Upright pianos are sometimes called *vertical pianos* cause their strings and soundboard are perpendicu-to the floor. These pianos take up less floor space— t also have poorer tone quality—than grand pianos. ere are three main kinds of upright pianos, the *spinet, console,* and the *studio.* A spinet stands between 36 d 38 inches (91 and 97 centimeters) high. A console asures between 36 and 40 inches (91 and 100 centi-meters) high, and a studio between 45 and 50 inches (114 and 130 centimeters) high.

Player pianos produce music automatically. They are operated by a roll of paper with patterns of holes that correspond to different notes. The roll moves over a cylinder, which also has small holes. A system consisting of a pump, bellows, and valves creates a vacuum in the cylinder. This vacuum sucks a stream of pressurized air through matching holes in the moving roll and the cylinder. The pressurized air causes the piano's hammers to move and strike the strings, producing music. Player pianos were popular during the late 1800's and early 1900's. The performances of many great pianists of that period have been preserved on player rolls.

Electronic pianos are often used in jazz and rock music. In one kind of electronic piano, the sound of the hammer striking the strings is picked up by a microphone and amplified electronically. The most popular type has no strings at all. Instead, all sound is produced by electronic means. This kind of electronic piano is small enough to carry, but it produces enough sound to fill a large auditorium. Both types have a keyboard. The number of keys varies from 54 to 88.

History

Several musical instruments, including the *dulcimer, clavichord,* and *harpsichord,* were forerunners of the piano. The dulcimer was probably invented in the Middle East during ancient times. It consists of a flat box with a set of wires across the top. The instrument is played by striking the wires with a mallet. The clavichord and harpsichord, which were developed by Europeans during the Middle Ages, were among the first string instruments with a keyboard.

In 1709, Bartolommeo Cristofori, an Italian who built musical instruments, invented a keyboard instrument with strings that were struck by hammers. Cristofori gave his invention the name *gravicembalo col piano e forte,* which means *harpsichord with soft and loud.* The name was later shortened to *pianoforte.* Cristofori's instrument was the direct forerunner of the modern piano.



The Metropolitan Museum of Art, New York City,
The Crosby Brown Collection of Musical Instruments, 1889

The pianoforte was the earliest piano. Bartolommeo Cristofori invented it in 1709. He made the one shown here in 1720.

Between the late 1700's and early 1800's, several musical instrument makers improved upon Cristofori's pianoforte. In the late 1700's, John Broadwood of England made many improvements in the piano. Broadwood's instrument produced louder and richer tones than the pianoforte. In 1821, Sébastien Érard of France designed the *double escapement,* a device that improved the action of the piano's hammers. Alpheus Babcock, an American, invented a large cast-iron frame in 1825. He also developed a method of cross-stringing pianos. In 1855, Henry E. Steinway, a German-born piano maker who moved to the United States, combined all these inventions in one piano. His piano closely resembled the grand pianos built today.

Since the late 1700's, most great classical composers have written music for the piano. Leading composers of piano music in the late 1700's and the 1800's included Ludwig van Beethoven, Johannes Brahms, Frédéric Chopin, Joseph Haydn, Franz Liszt, Wolfgang Amadeus Mozart, Franz Schubert, and Robert Schumann. Many classical composers of piano music, including Liszt and Chopin, were also accomplished players.

During the 1900's, leading composers of piano music included Béla Bartók, Claude Debussy, Paul Hindemith, and Maurice Ravel. Some American composers introduced major changes in piano music. For example, Henry Cowell introduced groups of notes called *tone clusters,* which are played with the palm, fist, or forearm. Cowell also called for pianists to strum the piano strings with their fingers. John Cage devised the *prepared piano,* in which paper clips, thumbtacks, and other objects are inserted between some of the strings. When the pianist strikes the keys for these strings, unusual sounds are produced. George Crumb electrically amplified the sound of the piano.

The leading pianists of the 1900's included Daniel Barenboim, Ferruccio Busoni, Van Cliburn, Glenn Gould, Myra Hess, Vladimir Horowitz, Sergei Prokofiev, Sergei Rachmaninoff, Arthur Rubinstein, and Rudolf Serkin. A few pianists of the 1900's, including Busoni, Prokofiev, and Rachmaninoff, also composed great piano music. F. E. Kirby

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Piatigorsky, *pyah tih GAWR skee,* **Gregor,** *GREHG uhr* (1903-1976), was a famous Russian-born cellist. His playing established him as one of the great cellists of his time. Piatigorsky collaborated in the 1960's with violinist Jascha Heifetz and violist William Primrose. These collaborations set the highest standards for chamber-music performance.

Piatigorsky was born on April 17, 1903, in Ekaterinoslav (now Dnepropetrovsk, Ukraine). He made his American concert debut in 1929 and became a United States citizen in 1942. Piatigorsky became an important teacher, settling in Los Angeles, California. While Piatigorsky was there, he spent time teaching master classes at the University of Southern California from 1962 until his death. Stephen Clapp

Picador. See Bullfighting.

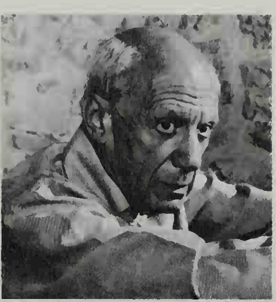
Picasso, *pih KAH soh,* **Pablo** (1881-1973), was the dominant figure in art of the 1900's. Picasso was primarily a painter, but he also exerted a great influence on printmaking, sculpture, ceramics, drawings, and designs for the theater. All modern artists have been influenced by Picasso's work, either directly or indirectly.

Early life. Pablo Ruiz Picasso was born on Oct. 25, 1881, in Malága, Spain. In 1895, after living in La Coruña for nearly four years, his family moved to Barcelona. Picasso learned the basic skills of painting from his father, José Ruiz Blanco, an artist and art teacher. In 1897 and 1898, Picasso lived in Madrid, where he spent much





Oil on canvas (1905); National Gallery of Art, Washington D.C., Chester Dale Collection
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© Karsh, Ottawa

Pablo Picasso was the dominant artist of the 1900's. *Family of Saltimbanques* is the masterpiece of Picasso's Rose Period, which began in late 1904. The large painting portrays a group of traveling acrobats. The figure on the left, dressed as the clown Harlequin, is a self portrait of the artist. The rose and pink colors of the painting are typical of Picasso's style during this period.

me in the Prado museum studying paintings by the reat artists who lived before him. He returned to arcelona in 1899.

The Blue Period. Picasso's artist friends in Barcelona ventually introduced him to the art world in Paris. He iade several lengthy visits to Paris before settling there ermanently in 1904. From 1901 to 1904, he developed a yle known as his Blue Period. During this period, Picas- painted primarily in blue colors, evoking a feeling of idness and alienation. A classic of the period is *The ld Guitarist* (1903), which appears in the **Color** article in *Vorld Book*. It is typical of Picasso's subjects during this eriod, which featured the poor of Paris, such as beg- irs and starving children. The guitarist's stretched-out, storted body and impossibly long fingers indicate the fluence of El Greco, a painter who worked in Spain uring the late 1500's and early 1600's.

After Picasso finally settled in Paris, he moved into a nement in the Montmartre section, nicknamed the *iteau Lavoir* (Laundry Boat) for the laundry barges that ocked on the Seine River there. He lived in the Bateau voir until 1909, with a growing circle of friends, no- bly painters, poets, actors, and critics.

The Rose Period. In late 1904, Picasso expanded his lection of colors, emphasizing rose and pink. At the me time, he eased the sadness of his subjects. This w style, called the Rose Period, concentrated on acro- ts who traveled from town to town. They were called *ltimbanques* and often featured the *harlequin* asked clown) and other characters who were popular the traditional Italian theater *commedia dell'arte* and pantomimes. Picasso often visited the Cirque Médrano near his Montmartre studio, which stimulated his interest in circus subjects. The appearance of circus figures in Picasso's art coincided with his friendship with the French poet Guillaume Apollinaire, whose verse is filled with references to harlequins and saltimbanques as symbols of both friendship and alienation.

The masterpiece of the Rose Period is *Family of Saltimbanques* (1905). At about 7 feet (2.1 meters) high and 7.5 feet (2.3 meters) wide, it was the largest painting of both the Blue and Rose periods. The painting displays almost no activity. The characters hardly notice each other. The stillness of the scene lends it mystery and a sense of melancholy. Picasso portrayed himself as Harlequin, as he did in many paintings. With the self portrait, this painting reflects Picasso's sense of artistic isolation or alienation. *Family of Saltimbanques* includes one figure thought to be from the Cirque Médrano, El Tío Pepe, a fat man in a bright red suit. The identity of the remaining figures remains controversial. Some scholars believe they represent Picasso's friends of the time.

Before Picasso completed *Family of Saltimbanques*, his work came to the attention of the American writer Gertrude Stein. Stein had lived in Paris since 1903 and was building one of the foremost collections of modern art in Paris. She met Picasso in 1905 and introduced him to the French painter Henri Matisse in 1906.

Early sculptures. In the summer of 1906, Picasso traveled to Gósol, a remote village in the Pyrenees mountains. Before he left for Gósol, he had discovered sculpture of the Iberian peninsula (present-day Spain and Portugal) from the 500's and 400's B.C. Under the influence of ancient Iberian sculpture, Picasso began to ex-

periment with distortion as an expressive element.

At the 1906 annual exhibition in Paris, called the Salon d'Automne, Picasso saw the work of the French artist Paul Gauguin in carved wood along with 10 paintings by the French painter Paul Cézanne. The achievements of these two artists and his response to them preoccupied Picasso over the next year or so and helped define his later work. Gauguin's use of forms found in the Pacific Islands, especially Tahiti, provided Picasso with an important model for using the art of non-Western cultures in his work.

Upon his return to Paris after that summer, Picasso completed a portrait of Gertrude Stein, begun months earlier. He gave the portrait a sculpturelike appearance by painting Stein with a masklike face and massive body of monumental chiseled forms.

Les Demoiselles d'Avignon is a large painting Picasso completed in 1907. Many art historians consider it the most influential painting of the 1900's because it opened the way to modern art. The painting appears in the **Cubism** article. The picture portrays five *demoiselles* (young women), prostitutes from Avignon Street in Barcelona, which Picasso knew well. Picasso reduced the figures to a series of interlocking, angular shapes. He filled the composition with sharp planes, distortions of space, and deliberately disorienting and contradictory points of view. Picasso used this distortion of the female form to express his anxieties about women, love, and sexuality. The painting reveals Picasso's attempt to harness the forms of non-Western carving and the power of magic and ritual in African art.

Cubism. Picasso and the French artist Georges Braque became acquainted in 1907, and a remarkable artistic dialogue between the two began in 1908. Together they produced a revolutionary style called Cubism, in which figures and objects are represented by geometrical forms.

In 1909, Picasso and Braque entered a period of great intensity in their work together. Their pictorial vocabularies merged in a phase called Analytic Cubism. Analytic Cubism broke down forms from the natural world and reassembled them into flat planes.



Oil on oilcloth on canvas edged with rope (1912) Musée Picasso, Paris (Art Resource © 2002 Estate of Pablo Picasso/Artists Rights Society (ARS), New York City)

Still Life with Chair Caning is a *collage*, a technique Picasso invented. He attached a piece of oilcloth printed with a pattern like chair caning and surrounded the painting with hemp rope.

During Picasso's Cubist period, he often painted *still lifes* (pictures of fruit, bowls, bottles, and other everyday objects). He drew his subjects from cafes and artist's studios, settings familiar to him. In 1912, the Cubist search for different styles of representation led Picasso to create *Still Life with Chair Caning*, and with it, to invent a technique called *collage*. Collage is a form of painting o drawing that attaches flat, readymade materials to the surface (see **Collage**). *Still Life with Chair Caning* shows objects scattered across a cafe table, including part of the newspaper *Le Journal*, a glass, and a lemon. To the painted objects, Picasso applied a real object, a piece of oilcloth printed with a pattern like chair caning. For a frame, Picasso surrounded the oval canvas with a length of thick hemp rope to make the collage look like an old master painting.

Picasso also created illusions in his three-dimensional constructions, beginning in 1912 with a series of sculptures called *Guitar*. One of these works appears in the **Sculpture** article. This *Guitar*, which Picasso completed in 1913, is constructed of sheet metal and wire. He cut away most of the guitar body and expressed its shape as a series of flat, projecting planes. He made the guitar's sound hole a projecting cylinder. In a real instrument, the hole would be an open space. Picasso's use of sheet metal, an industrial material, was highly unusual at that time, but such materials have since become common sculptural mediums. His invention of this radical new sculptural form had a great influence on later developments in sculpture.

By 1912, Picasso discovered that he could give shapes different meanings—real or abstract—simply by rearranging them. He also found that he could use a variety of materials on surfaces. Collage and the *Guitar* construction essentially ended Picassso's Analytic Cubist phase, and he began a second phase, called Synthetic Cubism, which lasted into the early 1920's. Synthetic Cubism generally constructed an image from many components. Instead of dissecting forms, as in Analytic Cubism, the artist added elements to the picture surface, building up the image through each addition, as Picasso did in *Still Life with Chair Caning* (1912).

When France joined World War I shortly after it began in 1914, Braque was called into the French military. Because Spain remained neutral during the war, Picasso continued working on art, but his collaboration with Braque came to an end.

Picasso as designer. A friendship with the French writer Jean Cocteau brought Picasso into the social circle surrounding the Ballets Russes in 1919. The Ballets Russes was a touring Russian dance company that included some of the greatest dancers, composers, and artists of the time. The first ballet Picasso became involved was *Parade*. Cocteau created the story, and Picasso designed the curtain, sets, and costumes. *Parade* premiered in 1917. Critics considered the ballet a radical break from traditional ballet, largely due to Picasso's designs. He continued to work on ballets until 1924, while also painting such Synthetic Cubist works as *Three Musicians* (1921).

The 1920's and 1930's. Picasso began to work in a different style in the 1920's, one he practiced alongside Cu



Guernica (1937), an oil painting on canvas; the Reina Sofia Museum, Madrid (MAS © Artists Rights Society, New York City)

uernica is one of Picasso's most powerful paintings. The artist painted this work as a protest against e bombing of the Spanish town of Guernica in 1937. Such images as a gored horse, a woman with a ead child, and a fallen soldier became emotional symbols of the bitter suffering of wartime.

sm. This style was his version of Neoclassicism in- ɔired by a trip to Italy in 1917. The artist began to use lassical forms and drawing techniques, reflecting the fluence of Mediterranean culture. *Three Women at the ɔring* (1921) shows its Classical roots in the facial fea- res and clothing of the large, serene figures.

Picasso never became an official member of the Sur- alist group during the 1920's, but he had close con- ections with several Surrealist members. The Surreal- ts used unexpected arrangements and distortions of nages to reflect dreams and the subconscious mind ee **Surrealism**). The Surrealist movement gave Picasso ew subjects. It also reinforced his interest in the frag- entation of forms and the expression of suppressed notions, qualities dating back to *Les Demoiselles d'Avi- ɔon*. Picasso's own brand of Surrealism also found a ique expression in poetry. He began to write in the ll of 1935 and continued into 1936. During that time, he ncentrated on poetry instead of painting.

In the mid-1930's, Picasso resumed painting with a ew political commitment. The outbreak of the Spanish vil War in 1936 stirred Picasso to produce work sup- ɔrting the cause of the Spanish Loyalists against the scists led by Francisco Franco.

The weakened Spanish Loyalist government asked Pi- sso to paint a mural for the Spanish Pavilion at the ris world's fair in 1937. The artist struggled to find a bject for the mural until he was inspired by the bomb- g of the Spanish town of Guernica, ordered by Franco. amatic photographs of the destruction of the small wn gave Picasso his subject matter.

Picasso painted *Guernica* in about a month in 1937. e canvas stretches more than 25.5 feet (7.8 meters) in ngth. The imagery of *Guernica*—a gored horse, a ɔman with a dead child, a fallen soldier—became werful symbols of bitter suffering. To dramatize the rtime agony of destruction, the artist restricted his lors to stark black, white, and gray.

Later career. After Germany invaded France in 1940, casso lived in his Paris studio, though he was banned from showing his work. Skulls began to appear in some of his paintings. They symbolized the tragedies that had touched the artist, including World War II (1939-1945), his mother's death in 1939, and the death of his friend, the Spanish sculptor Julio González in 1942.

After France was liberated in 1944, the Salon d'Automne of 1944 featured Picasso's work of the war years. These somber paintings shocked viewers, as did the announcement that Picasso had joined the French Communist party. His anti-American painting *Massacre in Korea* (1951) depicts American soldiers as medieval knights slaughtering innocent women and children.

From 1948, Picasso lived and worked in the south of France, at first for part of the year and later permanently. His international reputation had expanded, and his name had become virtually synonymous with modern art.

During the final two decades of his life, Picasso became fascinated with earlier art. He based paintings on works by two masters of the 1600's, the Dutch artist Rembrandt and the Spanish artist Diego Velázquez, and by French artists of the 1800's, including Eugene Delacroix and Edouard Manet. Picasso pitted himself in competition with his chosen masters, breaking their work down, recomposing it, and becoming ever bolder in his methods of painting.

Picasso's style continued to develop through the last decade of his life. At the time of his death on April 8, 1973, Picasso still owned hundreds of his own works in various mediums from all periods of his career. These pieces provided the basis of a gift to the French government by his heirs. In 1985 the Picasso Museum opened in Paris to display the works. Michael Plante

See also **Chicago** (picture: The Chicago Picasso); **Painting** (Cubism); **Sculpture** (Cubism and Futurism).

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Piccalilli is a popular relish made from chopped and pickled cucumbers, other vegetables, and spices.

Piccard, *pee KAHR* or *pih KAHRD,* is the name of a Swiss family of scientists who won fame in aeronautics and oceanography. Auguste and Jean Piccard, twin brothers, were born in Basel, Switzerland, and were educated in Zurich. Jacques Piccard, the son of Auguste, was born in Brussels, Belgium, and graduated from the University of Geneva.

Auguste Piccard (1884-1962), a physicist, invented an airtight *gondola* (passenger compartment) that he attached to a huge hydrogen-filled balloon. In 1932, he and an assistant, Max Cosyns, ascended in it 53,152 feet (16,201 meters) into the stratosphere and gathered information on cosmic rays (see **Balloon** [Manned explorations of the stratosphere]). In 1948, Piccard designed a deep-sea diving ship called a *bathyscaph* (see **Bathyscaph**). In 1953, he and his son, Jacques, descended 10,300 feet (3,140 meters) into the Mediterranean Sea in a bathyscaph named the *Trieste.* Piccard taught physics at the University of Brussels from 1922 to 1954.

Jean Piccard (1884-1963) was an aeronautical engineer and chemist. In 1934, he ascended by balloon more than 57,500 feet (17,530 meters) to study cosmic rays. In 1937, he made an ascent in an open gondola lifted by 98 balloons that measured 6 feet (1.8 meters) in diameter. This flight was the first manned ascent to use multiple balloons. Piccard became a United States citizen in 1931. He taught aeronautical engineering at the University of Minnesota from 1936 to 1952.

Jacques Piccard (1922-) is an oceanographic engineer. In 1960, in the bathyscaph *Trieste,* he and Lieutenant Don Walsh of the U.S. Navy descended 35,800 feet (10,910 meters) into the Pacific Ocean. In 1969, Piccard designed a special underwater craft for studying ocean currents. That year, he and five other scientists traveled in it along the Gulf Stream, a large ocean current off the east coast of the United States. During the 1970's, Piccard studied the effects of pollution on ocean life. Daniel J. Kevles

Piccolo is the smallest of the woodwind instruments and the highest in pitch. It measures about 12 inches (30 centimeters) long.

The piccolo is a member of the flute family. It is about half the length of the common concert flute and is played in the same way (see **Flute**). The piccolo sounds an octave higher than the concert flute, producing a bright, penetrating tone. The piccolo came into use as an orchestral instrument in the late 1700's and early 1800's. The instrument is also used in concert and military bands. André P. Larson

For a recording of the sound of a piccolo, see the **Piccolo** article in the CD-ROM version of *World Book.*

Pichincha, *puh CHIHN chuh* or *pee CHEEN chah,* a twin-cratered volcano, rises 15,696 feet (4,784 meters) in the Andes Mountains in north-central Ecuador (see **Ecuador** [map]). It last erupted in 1881. Climbers may ascend the peaks from Quito, which is about 5 miles (8 kilometers) to the southeast. On Pichincha's lower slopes, patriot forces defeated the Spanish royalists in the Battle of Pichincha in 1822, thus liberating Ecuador.

Gregory Knapp

Pickaroon. See Pirate.

Pickerel, *PIHK uhr uhl* or *PIHK ruhl,* is the name given to three small members of the pike family. Like all pikes, pickerels have large mouths and greedy appetites. They fight stubbornly when caught on a hook. Pickerels live in fresh water. They usually eat smaller fish.

The three kinds of pickerel are the *redfin pickerel,* also called *bulldog pickerel,* which lives east of the Allegheny Mountains from Maine to Florida; the *grass pickerel,* or *mud pickerel,* which is found abundantly in the Mississippi Valley; and the *chain pickerel,* which lives in lakes and streams east and south of the Alleghenies, from Maine to Florida and west to Arkansas. The redfin



WORLD BOOK illustration by Colin Newman, Linden Artists Ltd

The chain pickerel is a popular freshwater game fish. It lives in lakes and streams in the Eastern and Southern United States.

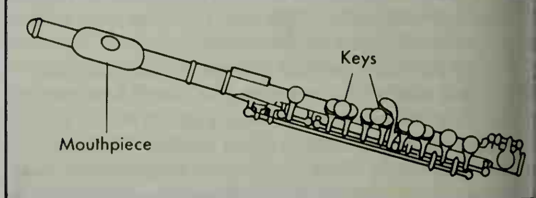
pickerel and the grass pickerel seldom grow more than 1 foot (30 centimeters) long. The chain pickerel commonly reaches a length of about 2 feet (61 centimeters). However, it may grow to about 3 feet (91 centimeters) long. The chain pickerel weighs up to 10 pounds (4.5 kilograms). It is a popular game fish, and its flesh is good to eat. Robert D. Hoyt

Scientific classification. Pickerels are in the pike family, Esocidae. The scientific name for the redfin pickerel is *Esox americanus americanus;* the grass pickerel, *E. americanus vermiculatus;* and the chain pickerel, *E. niger.*

See also **Pike**.



Northwestern University (WORLD BOOK photo by Ted Nielsen)



WORLD BOOK illustration by Oxford Illustrators Limited

The piccolo is the smallest of the woodwind instruments. A musician plays the piccolo like a flute, blowing across a hole in the mouthpiece while pressing keys that cover the tone holes.

ickering, John. See Impeachment (History).

ickering, Timothy (1745-1829), was a leading merican statesman. He served as postmaster general om 1791 to 1795, secretary of war in 1795, and secre-ry of state from 1795 to 1800. A member of the Federal-t Party, he represented Massachusetts in the United tates Senate from 1803 to 1811 and in the House of epresentatives from 1813 to 1817.

Pickering opposed the policies of Presidents Thomas fferson and James Madison. Beginning in 1804, he fa-ored unsuccessful plans to have New England secede om the Union. He was born in Salem, Massachusetts.

Richard D. Brown

icket. See Labor movement (Handling labor dis-utes; picture); Strike.

ickett, Bill (1870?-1932), was a famous African Ameri-n cowboy. As a working cowboy, he showed great ill at such jobs as branding, bronco riding, herding, nd roping. He went on to become a star rodeo per-rmer.

Pickett was born in Jenks-Branch, near Austin, Texas. is full name was Willie M. Pickett. By age 10, he had eveloped a unique style of bulldogging (now often illed steer wrestling). By 16, he was performing profes-onally. His bulldogging style involved leaping from his orse, grasping the steer by the horns, twisting its head oward, and biting its upper lip—forcing the animal on s side. This so-called "bite-em" style made Pickett the ar of the 101 Ranch Wild West Show, in which he per-rmed off-and-on from 1907 to the mid-1920's. He was lled as the "Dusky Demon." He performed before roy-ty in England.

Despite his stardom, Pickett was kept out of many ro-eos by racial discrimination. He worked as a cowboy n ranches throughout his rodeo career. Pickett died ss than a month after being kicked in the head by a orse he was trying to *break* (tame).

Nudie Eugene Williams

ickett, George Edward (1825-1875), was a Confed-rate general during the American Civil War (1861-1865). the Battle of Gettysburg in 1863, he took part in an un-ise charge that ranks as one of the most famous events American history. On July 3, Cemetery Ridge was a y to the Union Army's positions. Pickett's division and rts of other units charged up the hill in the face of avy fire and broke through a part of the Union lines. ldiers fought hand to hand. No help came to Pickett om the main Confederate lines, and at last the troops ll back after suffering ter-ble losses.

The failure of what be-me known as "Pickett's arge" ended the Battle of ettysburg, and General obert E. Lee retreated the xt day. The charge and e battle marked a turning int in the war. The Battle Gettysburg shattered the my of Northern Virginia, d the army never re-ined its former power. though Pickett continued command of his divi-sion, he was broken in spirit. He later served with General James Longstreet.


Chicago Historical Society
General George Pickett

Pickett was born in Richmond, Virginia, and graduated from the United States Military Academy in 1846. He served in the Mexican War (1846-1848) and on the Indian frontier. Pickett became a major general in 1862 and fought in the Battle of Seven Pines and at Fredericksburg. John F. Marszalek

See also **Gettysburg, Battle of.**

Pickett, Joseph (1848-1918), was an American folk artist. Pickett was a storekeeper, carpenter, and shipbuilder and painted only as a hobby. He had no art lessons. Pickett was born and lived in New Hope, Pennsylvania, where he found most of the subjects of his work. Only four of Pickett's paintings are known to exist.

Pickett's best-known painting, titled *Manchester Valley,* portrays New Hope High School. The painting shows Pickett's characteristic rich, vibrant color, complex line patterns, and thick, gritty textures. Pickett did not achieve recognition as a folk artist until after his death. Sarah Burns

Pickford, Mary (1893-1979), was a star of silent motion pictures. Pickford became known as "America's Sweetheart" because of her great popularity. She was famous for her portrayals of plucky and innocent young heroines.

Pickford made her film debut in 1909 and appeared in 194 movies. Among her most popular films were *The Poor Little Rich Girl* (1917) and *Rebecca of Sunnybrook Farm* (1917). Pickford won the 1928-1929 Academy Award as best actress for her performance in *Coquette.* She also received a special Academy Award in 1976 honoring her lifetime contribution to movies.


Bettmann Archive
Mary Pickford

Pickford was born in Toronto, Canada. Her real name was Gladys Marie Smith. She began acting on the stage at the age of 5. In 1919, she founded United Artists, a major Hollywood movie studio, with director D. W. Griffith and film stars Charlie Chaplin and Douglas Fairbanks, Sr. Pickford married Fairbanks in 1920. She retired from film acting in 1933.

James MacKillop

See also **Fairbanks, Douglas, Sr.**

Pickle is a vegetable or fruit preserved in vinegar or some other food acid. Pickles may be either sweet or sour. They are made with or without sugar and salt and are usually seasoned with spices.

The most common vegetable for pickles is the cucumber. Other vegetables and fruits often used in making pickles or *relishes* (chopped pickles with a sweet seasoning) are cabbage, carrots, cauliflower, olives, onions, peaches, pears, green and red peppers, tomatoes, and watermelon rinds.

The process of pickling begins by soaking the vegetable or fruit in *brine* (salty water). The acid that is responsible for the preservation of pickles is then either added by the food processing company or is produced by

bacteria in the brined pickle. Bacteria produce this acid by means of *fermentation* (a breaking down of chemicals in the pickle). To aid preservation, the processor may also use refrigeration or *pasteurization* (heating to kill harmful bacteria), or the processor may add chemicals to the brine.

Pickles are flavored with various seasonings, such as allspice, bay leaves, celery seed, cinnamon, cloves, dill, garlic, horseradish, mustard, and peppercorn. Pigs' feet, hard-boiled eggs, and other foods can also be preserved in a pickling solution. Henry P. Fleming

Picotte, Susan La Flesche (1865-1915), was the first American Indian woman to become a physician. She earned an M.D. degree in 1889 from the Women's Medical College of Pennsylvania in Philadelphia. She graduated at the top of her class.

Picotte, a member of the Omaha tribe, worked to improve medical care on the Omaha reservation in northeastern Nebraska. From about 1891 to 1894, she was head physician on the reservation. She later organized a county medical society and headed the local board of health. In 1913, Picotte established a hospital on the reservation. The hospital was named for Picotte after her death.

Susan La Flesche was born on June 17, 1865, on the Omaha reservation and attended government and mission schools there. Her father, the chief of the Omaha tribe, believed that education was a key to success in America. She studied at the Elizabeth Institute for Young Ladies in Elizabeth, New Jersey, and graduated from Hampton Institute in Hampton, Virginia. In 1894, she married Henry Picotte, a farmer of French and Sioux Indian ancestry. W. Roger Buffalohead

Pictograph, *PIHK tuh graf,* is picture writing. Before the development of the alphabet, many ancient peoples conveyed messages by pictographs. The Egyptians carved or painted pictographs on tombs and monuments. In addition, picture writing was a means of communication for the Aztec and for the early American Indians. Pictographs were of two kinds: those that represented objects, such as a drawing of the moon, and those that represented ideas, such as a drawing of a child with a book, to represent a student. Pictographs today may be used to show numbers or to tell a story. See also **Alphabet; Aztec** (Language; picture); **Graph; Hieroglyphics.** Charles F. Sieger

Pictou, *PIHK too* (pop. 3,875), is a port town in Nova Scotia. It lies on the south shore of Northumberland Strait, an inlet of the Atlantic Ocean. For location, see **Nova Scotia** (political map). The town's chief industries include fishing, pulp and paper manufacturing, shipbuilding, steelmaking, and tourism. Pictou has a mayor-council form of government and is the seat of Pictou County.

Micmac Indians lived in the area of what is now Pictou before white settlers arrived in 1767. In 1773, a large ship brought nearly 200 settlers from Scotland to Pictou. During the early 1800's, thousands of Scots came to Nova Scotia through this port. D. A. Sutherland

Picts, *pihkts,* were an ancient people of northern Scotland. The Picts were given this name by the Romans because they painted or tattooed their skin. The Latin word for *painter* is *pictor.* The first historical reference to the Picts occurs in a speech made by a Roman orator in A.D. 297. The Pictish tribes fought the Romans for many years. The Romans built two long walls to keep the Picts out of the province of Britain. Later, the Picts fought the Teutonic conquerors of Britain, the Angles and Saxons. They disappeared as a people about A.D. 900. See also **Scotland** (The Roman invasion). Robert S. Hoyt

Picture. See **Etching; Motion picture; Painting; Photography; Poster.**

Picture writing. See **Hieroglyphics; Alphabet; Cuneiform; Pictograph.**

Pidgin English, *PIHJ uhn,* is one of several *bridge* or *minimum* dialects, based on English, used in Asia and the South Seas between Westerners and Asians, and among peoples who have no common tongue. The word *pidgin* comes from a change in the pronunciation of the word *business.*

Pidgin English is sometimes viewed as a corruption of English, but it serves the needs of millions of people who would be unable to communicate without it. The phrase *long time, no see* is an example of Chinese Pidgin. Robert J. Kispert

Piece of eight was a name for the Spanish *peso,* which corresponded to the American dollar (see **Peso**). It was so named because it was worth 8 *reals* and once had an *8* stamped on it. The piece of eight was sometimes cut into pie-shaped smaller denominations called *bits.* The most popular size was the quarter, called *two bits.* The United States quarter is sometimes called *two bits* today. The piece of eight was used when pirate activity was widespread. The coin figures in many pirate stories, including *Treasure Island.* Burton H. Hobson





WORLD BOOK photo by James Sime

A piece of eight. Coins of this sort, known also as "Spanish milled dollars," were once widely used in the Americas. They were called "pieces of eight" because they were worth eight *reals,* the *real* being valued at about 12 $\frac{1}{2}$ cents. The coin pictured here was minted in Mexico during the reign of King Charles III of Spain.

Pied Piper of Hamelin, *HAM uh lihn,* is a mythical character who was made famous by Robert Browning in a poem based on a legend. According to the legend, the German town of Hamelin (now Hameln) was infested by rats. One day, a man dressed in a suit of many colors walked into Hamelin and offered to rid the town of the pests for a sum of money. When the mayor agreed, the man drew out a pipe and walked along the streets playing a haunting tune. All the rats came tumbling out of the houses and followed the Piper to the Weser River, where they drowned. When the Piper claimed his reward, the mayor refused to pay him. The Piper swore vengeance. Once more he walked along the streets



Mural (1909) by Maxfield Parrish, Pied Piper Bar, Palace Hotel, San Francisco

he Pied Piper bewitched the children of Hamelin by playing a haunting melody on his pipe. He
d them out of town and into a cave, which closed behind them. They were never seen again.

laying his strange melody. This time all the children ran
om their homes and followed him to a cave in the
earby Köppen Hill. The cave closed upon them, and the
hildren were never seen again.

This legend seems to be based at least in part on fact.
ld writings on the walls of several houses in Hamelin
ıy that on July 26, 1284, a Piper led 130 children out of
wn and that they were lost in Köppen Hill. Some be-
eve that the Piper was an agent of the bishop of
lmütz, who in the late 1200's drew many Hamelin lads
Moravia, where they settled. Others claim robbers
dnapped the children. It is also possible that the
gend came from the Children's Crusade of 1212.

James F. Poag

iedmont, *PEED mahnt,* is a territorial region in north-
estern Italy. It includes the upper valley of the Po River.
or location, see **Italy** (political map). The name *Pied-
ront* means *foot of the mountain.* It refers to the re-
ion's position at the base of the Alps. The region in-
udes the provinces of Alessandria, Asti, Cuneo,
ovara, Torino, and Vercelli and has about 4 $\frac{1}{4}$ million
eople. Turin is the capital and industrial center. Farm-
g is the chief economic activity in this fertile region. It
as once part of the Sardinian kingdom (see **Sardinia,
ingdom of**). Piedmont was the center of Italian national-
m in the 1800's, and its ruler, Victor Emmanuel II, be-
ıme the first king of Italy in 1861. David I. Kertzer

iedmont Region, *PEED mahnt,* is an area of gently
lling to hilly land lying between the Appalachian
ountains and the Atlantic Coastal Plain of the United
ates. It is sometimes called the Piedmont Plateau. It
as named for the Piedmont region in Italy. It varies in
idth from about 50 miles (80 kilometers) in the north to
ore than 125 miles (201 kilometers) in the south.

The division between the Piedmont Region and the
oastal Plain is marked by the Fall Line for the rivers
owing toward the Atlantic Ocean. Along this line,
reams from the west drop from the harder, rocky
ound near the mountains to the softer Coastal Plain.

Many large cities have developed along the Fall Line,
artly because of the access to water power and tidewa-
r. They include Newark, New Jersey; Philadelphia;
ashington, D.C.; Richmond, Virginia; and Columbia,
outh Carolina.

The Piedmont Region covers about 80,000 square
iles (207,000 square kilometers). It ranges in elevation
from 300 feet (91 meters) above sea level on the east to
1,200 feet (366 meters) on the west.

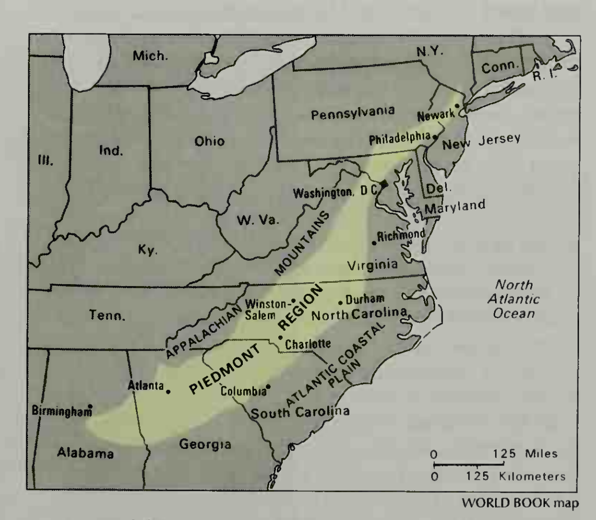
Tobacco is widely grown in the Piedmont Region. The
Piedmont cities of Winston-Salem, North Carolina, and
Richmond, Virginia, account for about half of the total
production of cigarettes in the United States. The Pied-
mont section of Virginia and Pennsylvania is fine apple-
growing country. The dairy industry is important in the
northern Piedmont. Furniture manufacturing is a major
industry in the central Piedmont. The southern Piedmont
is the leading U.S. cotton-textile producing area.

Stephen S. Birdsall

See also **Pennsylvania** (picture: A scenic Lancaster
County farm).

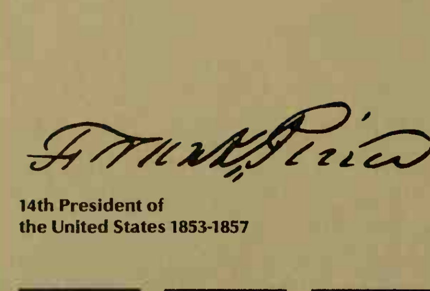
Pieplant. See **Rhubarb.**

Pier has several meanings. Two kinds of piers are used
in building construction. One kind is a block of concrete
or masonry that forms part of a building's foundation.
The other kind of pier supports a bridge and may be
made of concrete, steel, or timber. In architecture, sup-
porting pillars for arches or masonry walls are some-
times called piers. A pier may also be a platform that ex-
tends into a body of water for loading and unloading
ships. See also **Bridge; Building construction** (Founda-
tions); **Cofferdam.** William E. Saul



WORLD BOOK map

Location of the Piedmont Region



14th President of the United States 1853-1857



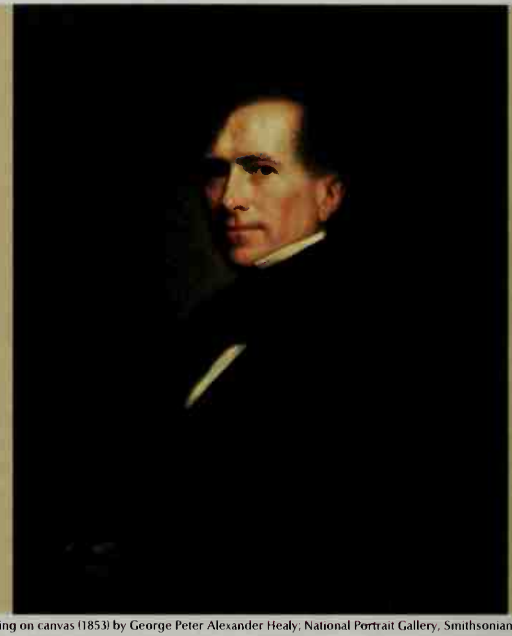
Fillmore
13th President
1850-1853
Whig



Pierce
14th President
1853-1857
Democrat



Buchanan
15th President
1857-1861
Democrat



Oil painting on canvas (1853) by George Peter Alexander Healy; National Portrait Gallery, Smithsonian Institution, Washington, D



William R. D. King
Vice President
1853

Pierce, Franklin (1804-1869), served as President during a period of increasing bitterness between North and South that later led to the Civil War. He won the Democratic nomination for President in 1852 after the four strongest candidates had fought to a stalemate. Pierce gained support because he strongly favored the Compromise of 1850, which sought to settle the slavery dispute. "If the compromise measures are not . . . firmly maintained," he said, "the Constitution will be trampled in the dust." At 48, Pierce became the youngest President of the United States up to that time.

The personal good looks of Pierce and his brilliant speaking manner impressed all who met him. People in New Hampshire respected his service as a U.S. representative and senator, and as a brigadier general in the Mexican War. But few people outside his home state had heard of Pierce until he ran for President.

As President, Pierce faced two difficult problems: (1) growing Northern opposition to any expansion of slavery, and (2) rising prejudice against immigrants. He angered Northerners by supporting the Kansas-Nebraska Act, which made slavery possible in a large area of the West. This act provided the issue that created the Republican Party. Pierce stirred up further opposition when he protected the rights of immigrants. Those opposed to granting rights to immigrants also formed a new party, called the Know-Nothing, or American, Party. By the time Pierce's term ended, the Democratic Party had lost much of its strength. Few Democrats favored Pierce for reelection.

Pierce's Administration marked one of the most prosperous periods in American history. The California gold rush still attracted people westward. Federal grants of land spurred railroads to extend their lines westward. And the Gadsden Purchase added land from Mexico to the Territory of New Mexico. The literary world discussed such new works as Henry David Thoreau's *Walden,* Henry Wadsworth Longfellow's *The Song of Hiawatha,* and Walt Whitman's *Leaves of Grass.* People hummed Stephen Foster's "My Old Kentucky Home, Good Night." At Christmastime in 1855, carolers sang "Hark! The Herald Angels Sing" for the first time.

Early life

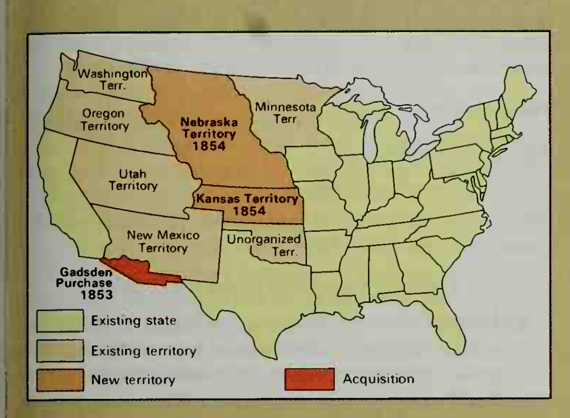
Franklin Pierce was born in Hillsboro, N.H., on Nov. 23, 1804. His father, Benjamin Pierce, had served in the Revolutionary War, and later became a brigadier general in the state militia. The elder Pierce served two terms as governor of New Hampshire. Franklin spent a happy childhood with his six older and two younger brothers and sisters.

At the age of 11, the boy was sent to the academy in nearby Hancock. Friends recalled that just after Franklin entered the school, he became homesick and returned home on foot. His father put him into a wagon, drove him halfway back to the academy, and left him at the roadside, never saying a word. The boy trudged the remaining 7 miles (11 kilometers) back to school. A year later, he transferred to the academy at Francestown, N.H., and later to Phillips Exeter Academy. In 1820, he entered Bowdoin College, where he became a close friend of classmate Nathaniel Hawthorne.

Pierce spent much of his college life in social activities. He joined literary and political clubs and became active in debating groups. At the end of his second year Pierce's marks were the lowest in his class. He then settled down to study. Pierce ranked third in his class when he graduated in 1824.

Political and public career

Pierce began studying law under Governor Levi Woodbury of New Hampshire. He later studied under Judge Samuel Howe and Judge Edmund Parker. In 1827, Pierce opened his own law office in Concord, N.H.



The Gadsden Purchase from Mexico in 1853 added new territory to the United States. Congress organized the Nebraska and Kansas territories in 1854.

The world of President Pierce

Japan emerged from world isolation after Commodore Matthew Perry of the United States Navy sailed to Tokyo Bay in 1853 and 1854. He negotiated a treaty that gave the United States trading rights at two Japanese ports.

The English explorer David Livingstone became the first European to cross the interior of Africa during an expedition that lasted from 1853 to 1856.

The Crimean War was fought from 1853 to 1856 between Russia and the allied forces of France, Britain, Turkey, and Sardinia. It ended in a Russian defeat.

Florence Nightingale of England took charge of a hospital in Turkey during the Crimean War and established new standards of nursing care and hospital administration. Her efforts saved countless lives and brought her international acclaim.

The Republican Party was established in 1854 by antislavery groups who opposed the Kansas-Nebraska Act. The act allowed citizens of the Kansas and Nebraska territories to decide for themselves whether to permit slavery.

Frederick Douglass, a runaway slave who became the leading spokesman for black rights in the 1800's, published an autobiography, *My Bondage, My Freedom,* in 1855.

The Bessemer steel process was invented by Sir Henry Bessemer of England in 1856. It was the first process that enabled large quantities of steel to be made inexpensively.

WORLD BOOK map

Entry into politics. Pierce supported Andrew Jackson's campaign for the presidency. In 1829, he won election to the New Hampshire House of Representatives. He was reelected two years later and became Speaker of the House. In 1833, Pierce won a seat in the United States House of Representatives. After serving two terms he was elected to the United States Senate. At 32, he became the youngest senator.

Pierce's family. Pierce's years in Congress were not happy. In 1834, he had married Jane Means Appleton (March 12, 1806-Dec. 2, 1863), whose father had been a Congregational minister and president of Bowdoin College. Mrs. Pierce suffered from tuberculosis. She disliked Washington and rarely went there. Pierce finally agreed to her wishes to come home and resigned from the Senate in 1842, shortly before his term ended. Mrs. Pierce's natural shyness deepened to melancholy after two of their three sons died in early childhood.

Soldier. Soon after the Mexican War began in 1846, President James K. Polk commissioned Pierce a colonel in the U.S. Army. A few months later, Pierce was promoted to brigadier general. He served under General Winfield Scott on the expedition to Mexico City. Pierce

Important dates in Pierce's life

1804 (Nov. 23) Born in Hillsboro, New Hampshire.
1833 Elected to the U.S. House of Representatives.
1834 (Nov. 10) Married Jane Means Appleton.
1836 Elected to the United States Senate.
1847 Served as brigadier general in the Mexican War.
1852 Elected President of the United States.
1869 (Oct. 8) Died in Concord, New Hampshire.

New Hampshire Department of Resources and Economic Development



Franklin Pierce was born in Hillsboro, New Hampshire, in a house that no longer exists. The Pierce family moved into the spacious Hillsboro house shown here when Franklin was 3 weeks old.



The Pierce Brigade, Concord, N.H.

Jane Pierce is shown above with the Pierces' son Benny, who died in an accident just before his father became President.

commanded a brigade in the attack on Churubusco and suffered a leg injury when thrown from his horse. He returned to the assault the next day. When close to the enemy lines, he wrenched his injured leg, fainted from pain, and lay helpless under fire until the end of the battle. Political enemies later accused him of cowardice.

Election of 1852. Pierce resumed his law practice in Concord after the war. He had become one of New Hampshire's leading Democrats by the time his party's national convention met in 1852. The delegates faced a difficult job in choosing a candidate for President who would be acceptable to all factions of the party. The four strongest candidates were Senator Stephen A. Douglas of Illinois and three former Cabinet members—James Buchanan, William L. Marcy, and Lewis Cass.

After 34 ballots, it began to appear that none of the favored candidates could win the nomination. Delegates from Virginia then nominated Pierce. The New Englander expected some Northern support, and the South trusted him because he had supported the Compromise of 1850 and endorsed strict enforcement of the Fugitive Slave Law. As the balloting continued, several Buchanan delegations swung to Pierce, and he won on the 49th ballot. The convention chose Senator William R. D. King of Alabama for Vice President.

The Whigs nominated General Winfield Scott for President and Secretary of the Navy William A. Graham for Vice President. The Compromise of 1850 had temporarily settled the slavery problem, and no real issues appeared to separate the two parties (see **Compromise of 1850**). But the campaign disclosed that Scott really opposed slavery, causing opposition to him in the South.

Pierce's election

Place of nominating convention	Baltimore
Ballot on which nominated	49th
Whig opponent	Winfield Scott
Electoral vote*	254 (Pierce) to 42 (Scott)
Popular vote	1,607,510 (Pierce) to 1,386,942 (Scott)
Age at inauguration	48

*For votes by states, see **Electoral College** (table).

Pierce won a majority of the popular vote and carried many more states than did Scott.

Pierce's Administration (1853-1857)

Cabinet. Pierce tried to promote harmony in the Democratic Party by choosing men from all factions for his Cabinet. His appointments consisted of two conservative Southerners (Guthrie and Dobbin), two conservative Northerners (Marcy and Campbell), an antislavery Northerner (McClelland), a states' rights Southerner (Davis), and a New England Whig (Cushing). Vice President King, who had been ill for several months, died in April 1853 without ever performing the duties of his office (see **King, William R. D.**).

Life in the White House began in an atmosphere of tragedy and grief for the Pierces. They had seen their 11-year-old son Benjamin die in a railroad accident just two months before the inauguration. Mrs. Pierce collapsed from grief and did not attend her husband's inauguration. She secluded herself in an upstairs bedroom for nearly half of his term. Washington gossips called her "the shadow in the White House."

Mrs. Abby Kent Means, an aunt of Mrs. Pierce, served as White House hostess during Pierce's first two years in office. Mrs. Pierce finally appeared at a White House function on Jan. 1, 1855, and thereafter attended state dinners frequently. But one visitor remarked that she remained the "very picture of melancholy."

The Kansas-Nebraska Act. In January 1854, Senator Douglas introduced a bill that he hoped would hasten frontier settlement. It proposed to carve two new territories, Kansas and Nebraska, out of the Indian lands in the West. The bill provided that settlers in the new territories would decide for themselves whether to permit slavery. Douglas' bill threatened to upset the uneasy slavery truce established by the compromises of 1820 and 1850. A farsighted statesman would have seen the danger in such a law. But Pierce, acting on the advice of his party leaders, supported the bill. It became law on May 30, 1854 (see **Kansas-Nebraska Act**). Both slavery and antislavery people poured into Kansas. Each group sought to control the territory. Their rivalry soon developed into armed clashes (see **Kansas** ["Bleeding Kansas"]).

Vice President and Cabinet

Vice President	*William R. D. King
Secretary of state	William L. Marcy
Secretary of the treasury	James Guthrie
Secretary of war	*Jefferson Davis
Attorney general	Caleb Cushing
Postmaster general	James Campbell
Secretary of the Navy	James C. Dobbin
Secretary of the interior	Robert McClelland

*Has a separate biography in *World Book*

The Kansas-Nebraska Act created a violent realign-
ıent of political parties. The Democrats defended the
xisting laws on slavery. The Whigs, already weakened
y sectionalism, disintegrated. This hastened the birth of
ıe new Republican Party and the Know-Nothing Party
ee **Know-Nothings; Republican Party**).

Foreign affairs. In his inaugural address, Pierce had
oldly summarized his attitude toward foreign policy by
ıying: "My administration will not be controlled by any
mid forebodings of evil from expansion." In 1853, he
dvocated annexing Hawaii. This plan fell through, partly
ecause King Kamehameha died. The Gadsden Purchase
f 1853 gave the country a southern railroad route to the
acific Coast and settled the boundary question with
Mexico (see **Gadsden Purchase**). At Pierce's insistence,
ıe Senate ratified a trade treaty with Japan in 1854,
pening Japan to American trading interests.

Acts of this kind fitted well with the attitude of Ameri-
ans, who believed in national expansion. But when
ıree of Pierce's diplomats claimed in 1854 that the Unit-
d States had the right to seize Cuba from Spain, the
ublic reacted against Pierce. See **Ostend Manifesto**.

Later years

Pierce's handling of the slavery issue destroyed his
olitical usefulness. After the inauguration of James
uchanan, Pierce and his wife went abroad in a futile at-
empt to improve her health. The Pierces spent two
ears on the island of Madeira, visited Europe, and then
eturned home. Mrs. Pierce died on Dec. 2, 1863.

Pierce became a bitter critic of President Abraham
incoln during the American Civil War. He charged that
incoln could have avoided the conflict by proper lead-
rship. Pierce died on Oct. 8, 1869, and was buried in
ıe Old North Cemetery at Concord. Philip S. Klein

Related articles in *World Book* include:

adsden Purchase	King, William R. D.
ansas-Nebraska Act	President of the United States

Outline

I. Early life
II. Political and public career
- A. Entry into politics
- B. Pierce's family
- C. Soldier
- D. Election of 1852

III. Pierce's Administration (1853-1857)
- A. Cabinet
- B. Life in the White House
- C. The Kansas-Nebraska Act
- D. Foreign affairs

IV. Later years

Questions

Vhy did Pierce's position on the Kansas-Nebraska Act turn Northerners against him?
Vhat tragedy influenced Pierce's life in the White House? Who was "the shadow in the White House"?
Vhy did Pierce win the Democratic presidential nomination over better-known candidates?
Vhy was Pierce accused of cowardice during the Mexican War?
Vhy was Pierce rejected for renomination?

Additional resources

ıara, Larry. *The Presidency of Franklin Pierce.* Univ. Pr. of Kansas, 1991.
lichols, Roy F. *Franklin Pierce.* Rev. ed. 1969. Reprint. Am. Political Biography Pr., 1993.

Pierce, Samuel Riley, Jr. (1922-2000), served as sec-
etary of the Department of Housing and Urban Devel-
pment (HUD) from 1981 to 1989. He became the first
lack to serve in President Ronald Reagan's Cabinet.

In 1989, the U.S. Congress investigated Pierce on charges of mismanagement and abuse of resources and funds as secretary of HUD. The investigators concluded that, under Pierce, HUD had become a center of influence peddling and favoritism toward Pierce's friends and political allies. In the early 1990's, several of Pierce's aides were found guilty or pleaded guilty to charges related to influence peddling and favoritism. In 1995, prosecutors announced that Pierce would not be charged.

Pierce was born in Glen Cove, New York. He graduated from Cornell University in 1947 and received a law degree from Cornell Law School in 1949. He earned a Master of Laws degree from New York University School of Law in 1952. From 1953 to 1955, he was an assistant United States attorney in New York. In 1955, he became an assistant to the undersecretary of labor. Pierce served as a New York state judge in 1959 and 1960 and as general counsel for the Department of the Treasury from 1970 to 1973. Lee Thornton

Piero della Francesca, *PYAIR oh DEHL uh fran CHEHS kuh* (1420?-1492), was an Italian Renaissance painter. Piero favored calm, restrained figures in clear, simple spaces. His works combine precise contours and carefully created illumination with sensitive color and harmonious design. In the *Baptism of Christ,* he painted early morning light over a quiet landscape to set a gentle, dreamlike mood. This painting is reproduced in the **Jesus Christ** article. Piero's most famous work is the series called *The Legend of the True Cross,* painted in *fresco,* which means it was painted on damp plaster. In one episode, *The Dream of Constantine,* Piero used bright artificial light and deep shadow for dramatic effect.

Piero was born in Sansepolcro, Italy, near Arezzo. In Florence, Piero learned to paint in the new Renaissance style of the artists Masaccio, Fra Angelico, and Domenico Veneziano. He also learned the construction of perspective, which fascinated him. From Domenico Veneziano in particular, Piero acquired skill in the treatment of light and delicate color. David Summers

See also **Easter** (picture: The Resurrection).

Pierpont, Francis Harrison (1814-1899), was governor of the "Restored Government of Virginia" during the American Civil War. *Restored Government of Virginia* was the name given to some northern counties of Confederate Virginia that Union forces had occupied.

Pierpont was born near Morgantown, Virginia (now in West Virginia). His family name has also been spelled *Pierpoint.* He became a lawyer, joined the Whig Party, and strongly opposed slavery. In 1861, Virginia *seceded* (withdrew) from the Union. Pierpont then led a movement in western Virginia to establish a state government loyal to the Union. A convention of western Virginians declared all state offices vacant and chose Pierpont as provisional governor. He set up a loyal legislature of members from western Virginia. The convention wrote a new state constitution and, in 1863, Congress approved West Virginia's admission to the Union. The new state chose Arthur I. Boreman as its first governor, and Pierpont became head of the Restored Government of Virginia. President Abraham Lincoln considered him to be governor of Virginia for the rest of the war. After the Confederacy surrendered in 1865, Pierpont moved to Richmond and continued as governor under federal military authority until 1868. James E. Sefton

Pierpont Morgan Library is a museum and center for scholarly research in New York City. The museum ranks among the world's greatest treasuries of artistic, historical, literary, and musical works. The collection consists of rare books and manuscripts, prints and drawings, paintings, and other art objects. It concentrates on the art, history, and literature of Western civilization from the Middle Ages to the 1900's.

The museum is located in a complex of buildings between Madison and Fifth avenues on 36th Street. The complex includes the former town house of American banker John Pierpont Morgan, Jr. It also includes the library commissioned by Pierpont Morgan, Sr., and designed by the firm of McKim, Mead & White and completed in 1906. John Pierpont Morgan, Jr., founded the institution in 1924. The two Morgans assembled much of the museum collection, which continues to be enlarged. Critically reviewed by the Pierpont Morgan Library

Pierre, *peer* (pop. 13,876), is the capital of South Dakota. It also serves as the chief trading center of a large agricultural region. Pierre lies on the east bank of the Missouri River, near the center of South Dakota (see **South Dakota** [political map]).

The State Capitol, completed in 1910, has a central rotunda, flanked by legislative wings. Many of Pierre's residents work in the city's state and federal government offices. The livestock industry is also a major employer.

Pierre was named for Pierre Chouteau, an early fur trader. The first permanent settlers arrived in 1878. The Chicago and North Western Railway reached the settlement in 1880. The town prospered as the railroad terminus. This portion of the Chicago and North Western is now the Dakota, Minnesota and Eastern Railroad. Pierre became the state capital in 1889, shortly after South Dakota was made a state.

Pierre is the seat of Hughes County. It has a mayor-council form of government. Edward Patrick Hogan, Sr.

Piers Plowman. See **Langland, William.**

Pietà. See **Michelangelo.**

Pietermaritzburg, *PEE tuhr MAR ihts burg* (pop. 156,473; met. area pop. 211,473), is the capital and a major trading center of the province of KwaZulu-Natal in South Africa. For location, see **South Africa** (political map). The city's factories produce aluminum, rubber, and furniture. Pietermaritzburg has a university, a teac ers college, and many parks and gardens. *Boers* (peo of Dutch, German, or French ancestry) founded the ci in 1838. Today, many people in Pietermaritzburg are d scendants of immigrants from what are now India an Pakistan. The city's largest population group consists Zulus, a black ethnic group. Bruce Fetter

Piezoelectricity, *pee AY zoh ih LEHK TRIHS uh tee,* i an electric phenomenon that occurs in certain nonmetallic minerals, such as quartz, Rochelle salt, and to maline. These crystals develop an electric charge on their surfaces when they are stretched or compresse along an axis. In addition, voltage applied to such crys tals causes them to expand and contract, producing vi brations. Crystals that have these properties are called *piezoelectric crystals.* Pierre and Jacques Curie, two French physicists, published their discovery of piezoelectricity in 1880.

Piezoelectricity has many uses. Piezoelectric crystals control the frequency of electric current in radio trans mitters. The crystals are cut so that only signals of a ce tain frequency can pass through them. Piezoelectric crystals in a phonograph pickup cartridge convert the vibrations of the phonograph needle into a varying ele tric signal. Piezoelectric crystals are also used in micro phones and other electronic devices that change soun waves into electric signals. Thomas T. Liao

See also **Quartz.**

Pig. See **Hog.**

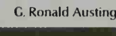
Pig iron. See **Iron and steel** (Pig iron).

Pigeon is any of the larger members of the pigeon a dove family. The smaller members are usually called *doves.* In this article, the term *pigeon* refers to both pigeons and doves.

There are about 300 species of pigeons. They live in all parts of the world except the Arctic, Antarctic, and some oceanic islands. Most species live in tropical climates. For example, 24 species of pigeons make their home in Mexico. Only 11 species live in the United States, and only 3 species are found in Canada.

The body of a pigeon

Pigeons have a plump body, a small head, and short sturdy legs. They are swift, powerful fliers. The large


G. Ronald Austing



Pigeons are common in mo large cities. They usually bui their nests of loose-fitting sticks. The male, *right,* and fe male, *left,* both help raise th young, which are called *squabs.*

light muscles in a pigeon's chest may be two-fifths of he bird's total body weight. The feathers of pigeons are tiffer and smoother than those of most other birds. heir texture smooths the flow of air around the pi- jeon's body during flight. Some kinds of pigeons have pecially shaped feathers that may help them fly at peeds slower than normal. The feathers of other spe- ies produce sounds during flight. These pigeons com- nunicate with one another by means of these sounds.

Most species of pigeons measure from 10 to 15 nches (25 to 38 centimeters) long. One of the smallest pecies, the *common ground-dove,* grows about 6 nches (15 centimeters) long and weighs about 1 ounce 28 grams). The largest species, the *Victoria crowned-)igeon,* is almost 3 feet (91 centimeters) long and veighs from 2 to 3 pounds (0.9 to 1.4 kilograms).

Most pigeons have dull-colored feathers that are)lack, blue, brown, or gray. The males and females of nost species look much alike, but the males are a little arger and brighter. Some species, such as the *Asian ruit-pigeon* and the *bleeding-heart pigeon,* rank among he most beautiful birds in the world. These birds have)right markings on the front parts of the body. A pigeon nay use its markings to attract a mate or to threaten)ther pigeons of the same species that approach its nest)r territory.

Pigeons drink in an unusual way. They do not tip their head up with each sip, as most birds do. Pigeons thrust their beak into the water and suck the liquid through it as though it were a straw.

The life of a pigeon

Most pigeons build their nests in trees. But one species, the *rock pigeon,* nests on rocky cliffs or on the lower ledges and sills of buildings. Other species, called *ground-doves,* build their nests on the ground.

Pigeons begin to look for food and water early in the morning. They generally rest during part of the afternoon and then seek more food and water. The birds return to their roost before nightfall.

Most species of pigeons live in the same region throughout the year. However, many species that live in cool regions migrate in large flocks during the fall and spring. People often hunt pigeons during these migrations.

Food. Pigeons eat fruits, grains, and nuts, and they sometimes feed on insects, snails, and worms. Most pigeons also eat grit and minerals such as salt. Some species obtain food by pecking at the ground. Others do not usually land on the ground and so feed in trees.

Flocks. When not breeding, most species of pigeons live in flocks. These flocks may consist of more than one



Ken Brate, Photo Researchers

The fantail pigeon is valued for its beautiful fan-shaped tail. The fantail struts about with its breast puffed out. It is specially)red as a show bird.



G. Ronald Austing

The Jacobin pigeon is a prized show bird in the United States and Europe. A thick growth of feathers flares over its neck, forming a hood, or ruff.



G. Ronald Austing

The bleeding-heart pigeon jets its name from the red)atch on its chest.



Jack Fields, Photo Researchers

The Victoria crowned-pigeon is the largest pigeon. It is hunted for its plumage.



G. Ronald Austing

The homing pigeon is often used for racing and carrying messages. This bird is noted for being able to find its way home from great distances.

species. The large number of birds in a flock increases the chances of finding food. Flocks also provide protection against such enemies as cats, hawks, martens, owls, and rats. Some pigeon flocks include other species of birds, such as blackbirds and sparrows. The presence of these birds further improves the chances of locating food and of being warned of danger.

Life history. Male and female pigeons pair for the breeding season and may remain paired for life. Most other kinds of birds pair for a single nesting cycle or a single season. During courtship, the male pigeon bows and coos to the female while the female watches him. The two birds groom each other's feathers, and the male feeds the female a few seeds. The courtship lasts a few days, after which mating occurs.

Pigeons build a shallow, but often strongly interwoven nest of twigs and grass. In most species, the female lays two white eggs. The parents take turns sitting on the eggs, which hatch in about 17 days. The young, called *squabs,* are blind and almost featherless. They grow rapidly. Some of the smaller species can fly before they are two weeks old.

Both parents feed the newly hatched young a white liquid called *crop milk.* The milk, which is similar to the milk of mammals, is produced in the *crop,* a sac in the base of the neck of the parents. The parents pump the milk down the throat of the squabs. The young begin to eat solid food after about 10 days.

Most pigeons that survive the first few months live from three to five years. The larger species live longer than the smaller ones.

Kinds of pigeons

There are two main groups of pigeons, wild and domestic. Domestic pigeons are bred by people.

Wild pigeons. Of the nearly 300 wild species, some of the best known are the Victoria crowned-pigeon, the fruit-pigeon, the bleeding-heart pigeon, the rock pigeon, the band-tailed pigeon, and the mourning dove.

Victoria crowned-pigeons, the largest of all pigeons, live in New Guinea. They have a variety of colors, and tufts of thin, lacy feathers form a crest on their head. The brightly colored fruit-pigeon is found in Asia and on islands in the South Pacific Ocean. Its nest is so flimsy that the female must hold her eggs and the nest in place if even a slight wind blows. The bleeding-heart pigeon of the Philippines has white underparts except for a bright red spot on its chest.

The rock pigeon nests on cliffs in Africa, Asia, and Europe. It is dark blue and has two black stripes on its wings, a white rump, and a black band on its tail. The feathers on its neck are glossy green and purple. The band-tailed pigeon, a favorite game bird that makes its home in the western part of the United States, has a black band across its tail. Hunters shoot thousands of these pigeons every fall for food and sport.

The mourning dove is the most common of the smaller North American wild pigeons. It makes a sad, cooing sound and is well known as both a game bird and songbird. Conservationists try to control the number of mourning doves killed by hunters. Another game bird, the *passenger pigeon,* was hunted to extinction in the 1800's and early 1900's. The last passenger pigeon died in the Cincinnati Zoo in 1914.

Domestic pigeons. Scientists believe that most breeds of domestic pigeons are the descendants of wi rock pigeons. Many of these birds differ greatly from their wild ancestors. But if a domestic pigeon become wild, its descendants resemble their wild ancestors aft several generations. For example, city pigeons, which are wild descendants of a number of domestic breeds, resemble wild rock pigeons.

Rock pigeons were domesticated in Egypt about 31 B.C. Through the centuries, breeders have developed over 150 types of pigeons for various purposes. Pigeon have been bred to serve as a source of food, to carry messages, or for racing, recreation, or show.

Popular types of pigeons raised for food include the *carneaux pigeon,* the *dragoon pigeon,* the *white malte pigeon,* and the *white king pigeon.* These birds produc large squabs that many people consider a delicacy.

People use *homing pigeons,* also called *homers,* to carry messages and for racing. These pigeons have a re markable ability to find their home loft from great distances. *Carrier pigeons* are also used to carry message These large, swift birds have fleshy growths of skin called *wattles* around their beak and eyes.

Pigeon shows feature specially bred varieties of pigeons. Birds displayed in such shows include the *fantai pigeon,* the *pouter pigeon,* and the *Jacobin pigeon.*

Other domestic breeds include the *tumbler pigeon* and the *roller pigeon,* both of which perform acrobatic in the air. One domestic type, the *ringed turtle dove,* ha unknown ancestors.

Pigeons and human beings

People hunt pigeons for both food and sport. They also use these birds for scientific research. For example scientists study ringed turtle doves to better understand how hormones control behavior. Scientists also study homing pigeons in an effort to learn how birds are able to find their way when flying great distances.

Some kinds of pigeons eat large amounts of grain raised by farmers. But other species eat the seeds of var ious harmful weeds. Several species of pigeon depend directly on people. Since 1930, for example, the *collared dove* has spread throughout Europe by relying on crops for food and buildings for shelter.

Pigeons that live in cities can be a great nuisance to people. The droppings of large numbers of pigeons are expensive to clean up and may help erode stone and marble. The droppings may also stop up the roof drains of buildings. The birds also can spread such diseases as histoplasmosis and psittacosis, which affect the lungs and other organs of human beings (see **Histoplasmosis; Psittacosis**).

Scientific classification. Pigeons and doves make up the family Columbidae in the order Columbiformes. The scientific name for the common ground-dove is *Columbina passerina.* The bleeding-heart pigeon is *Gallicolumba luzonica.* The Victoria crowned-pigeon is *Goura victoria.* The rock pigeon is *Columba livia,* and the band-tailed pigeon is *C. fasciata.* The mourning dove is *Zenaida macroura.* The ringed turtle dove is *Streptopelia risoria.* Edward H. Burtt, Jr.

Related articles in *World Book* include:

Bird (pictures)	Homing pigeon	Poultry
Carrier pigeon	Mourning dove	Reuter, Baron de
Guillemot	Passenger pigeon	Turtle dove

Pigfish. See Grunt.

igment is a finely powdered, highly colored sub-
tance used to give color to another material. It does so vhen mixed with the material or applied over the mate-
ial's surface in a thin layer. Pigments mixed with a liquid lo not dissolve, but remain suspended in the liquid. olored substances that dissolve and give their color ef-
ects by staining are called *dyes.* Manufacturers use pig-
nents in such products as ink, paint, and plastics. The ame types of pigment are used in all products. Some igments are produced chemically. Others come from atural sources. See also **Paint; Painting** (Materials and echniques); **Albino; Color; Hair** (Color and texture); **kin.** George J. Danker

igmies. See **Pygmies.**

igweed is the name of several species of weeds ound in many regions worldwide. The *redroot pigweed* as large, coarse leaves that may be covered with stiff airs. Its small greenish flowers grow in densely rowded branchlike heads. This weed measures 4 to 10 eet (1.2 to 3 meters) in height. The *smooth pigweed* may row 6 feet (1.8 meters) high. Its leaves and flowers may e green or reddish. Pigweeds can be killed by uproot-
ng the plants completely or by spraying with a *herbi-
ide* (chemical weedkiller).

Scientific classification. Pigweeds belong to the amaranth amily, Amaranthaceae. The scientific name for the redroot pig-
veed is *Amaranthus retroflexus.* The smooth pigweed is *A. hy-
ridus.* Harold D. Coble

See also **Amaranth; Lamb's-quarters.**

ika, *PY kuh,* is a small, furry animal that lives in Asia, urope, and western North America. Pikas belong to the ame animal order as hares and rabbits, but they look nuch more like guinea pigs.

The *American pika,* also called *cony, conie, little chief are,* or *calling hare,* is about 7 inches (18 centimeters) ong with a 1-inch (2.5-centimeter) tail. Its coat is grayish-
rown on the back and white or light brown on the un-
lerside. American pikas live among loose rock on nountainsides, above the *timber line* (highest area vhere trees can grow). Pikas eat plants and spend much ime collecting food for winter. The animals often live in arge groups called *colonies.* They give loud, squeaking alls to warn others of such enemies as eagles and wea-
els.

Scientific classification. Pikas belong to the genus *Ocho-
na* in the pika family, Ochotonidae. Anne Innis Dagg



C. Summers, Tom Stack & Assoc.

he American pika is a small, furry animal that lives among ose rock on mountainsides. The pika resembles a guinea pig.



© Hans Reinhard, Bruce Coleman Inc.

The northern pike is a large freshwater fish that is popular as a fighting game fish and also as a delicious food fish.

Pike is the common name of a family of freshwater fish noted for their greedy appetite and fighting quality. Members of the pike family have long, slender bodies and a duckbill-shaped snout filled with many teeth. Two members of the pike family are called *pickerel:* the *bull-
dog pickerel,* also called the *redfin pickerel,* the *mud pickerel,* or the *grass pickerel;* and the *chain pickerel.* The three forms of muskellunge also are in the pike fam-
ily. The so-called *pike perch,* more accurately called *walleye,* is a perch. The *gar pike* (garfish) is a gar. See **Muskellunge; Pickerel.**

The *northern pike* and the muskellunge are the most important members of the family. They are often dis-
played as trophy fish. The northern pike lives in the northern fresh waters of Europe and Asia, and in the Great Lakes and smaller lakes in Canada and the upper Mississippi Valley of North America. The northern pike may grow to be 4 feet (1.2 meters) long and weigh more than 40 pounds (18 kilograms). It commonly weighs from 2 to 10 pounds (0.9 to 4.5 kilograms). It is bluish- or greenish-gray, with irregular rows of whitish or yellow-
ish spots. The northern pike is a fine game fish. Its flesh is good to eat.

Scientific classification. The northern pike belongs to the pike family, Esocidae. Its scientific name is *Esox lucius.*

Robert D. Hoyt

Pike, James Albert (1913-1969), was a controversial American clergyman. He became an Episcopal bishop—reaching a peak of his profession—and then began to question some of the basic teachings of his church.

Pike was born in Oklahoma City. He was raised a Roman Catholic but drifted away from formal religion. In 1944, Pike joined the Episcopal Church. He was or-
dained a priest in 1946, and in 1952 he became dean of the Cathedral of St. John the Divine in New York City. There, Pike gained a national reputation as a theologian and preacher with his vigorous support of the church and attacks on social injustice. In 1958, he was elected bishop of the Episcopal Diocese of California.

In 1960, Pike publicly expressed discontent with sev-
eral Episcopal doctrines, including those on the Trinity and the virgin birth. He resigned as bishop in 1966 and in 1969 announced that he was leaving the church. Pike said he still believed in God, Christ's Resurrection, and life after death. However, Pike's religious practice during this period included mysticism and attempts to commu-
nicate with the dead as well as traditional Christian ele-
ments. In 1969, Pike went to Israel to investigate the ori-
gins of Christianity. He died there, in the Judean desert.

Charles H. Lippy

Pike, Zebulon Montgomery, *ZEHB yu luhn* (1779-1813), an American general and explorer, won fame for his discovery of Pikes Peak, a mountain in the Colorado Rockies, in 1806. Pike's first important mission was to explore the upper Mississippi River in 1805.

In 1806 and 1807, Pike explored the southwestern United States. While following the Arkansas River, he sighted the peak that now bears his name from at least 150 miles (241 kilometers) away. He later turned south to find the source of the Red River but instead followed the Rio Grande into Spanish territory. Spanish troops met Pike and took him and his men as captives to Santa Fe (now in New Mexico). They were released months later.

Pike returned from his trip with valuable information about the area for the U.S. government. He was ordered on this mission by General James Wilkinson, who may have been plotting an illegal invasion of Spanish territory in the area with American statesman Aaron Burr. Some historians believe Pike was spying for Wilkinson.

Pike was born in Lamberton (now a part of Trenton), New Jersey, on Jan. 5, 1779. He began his military career at the age of 15. In the War of 1812 (1812-1815), he led a successful advance on York (Toronto), Canada, in which he lost his life. Dan L. Flores

Pikes Peak is probably the best known of the Rocky Mountain peaks in Colorado. It is the first one seen as travelers approach from the east. It lifts its snow-capped peak 14,110 feet (4,301 meters) above sea level, in the Front Range (see **Colorado** [physical map]). Pine and spruce forests grow to a height of 11,700 feet (3,566 meters) on its slopes.

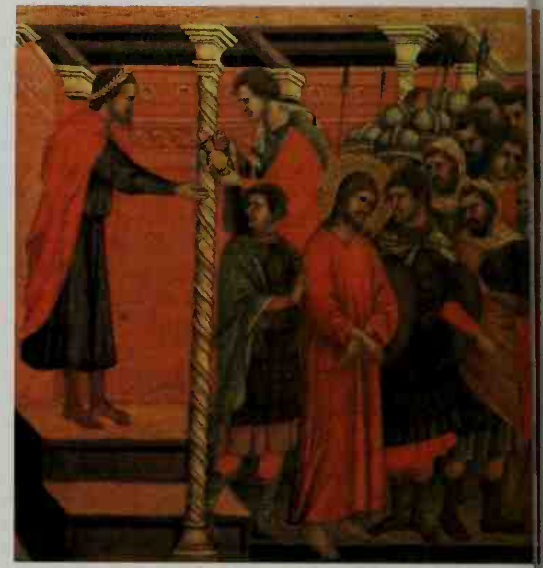
The mountain was named for Lieutenant Zebulon Montgomery Pike. In November 1806, Pike climbed partway up the mountain, but lack of supplies forced him to turn back. Major Stephen Harriman Long led an exploring party to the top in 1820.

Today, the top of Pikes Peak can be reached on horseback or by a 9-mile (14-kilometer) cog railway. A 30-mile (48-kilometer) automobile highway leads to the top from Colorado Springs, 12 miles (19 kilometers) to the east. The famous Pikes Peak Auto Race is held there every summer. A huge searchlight was installed on top of the mountain in 1905. The National Weather Service maintains one of the highest meteorological stations in the world on Pikes Peak. Pikes Peak is the center of one of the most popular mountain-resort areas in America. Denver is located 65 miles (105 kilometers) north of the peak. John L. Dietz

See also **Colorado** (pictures); **Mountain** (diagram: Major mountains); **Pike, Zebulon Montgomery.**

Pilate, *PY luht,* **Pontius,** *PAHN shus,* was a Roman governor of Judea from A.D. 26 to 36, at the time of the Crucifixion of Jesus Christ. Information about Pilate comes from two sources, the New Testament and Jewish writers from Pilate's time to about A.D. 100. The New Testament portrays him as generally weak and poor at making decisions, while the Jewish sources depict him as a strong figure of authority. Both sources report that he was unjustly hostile toward the Jews. His name was found in 1961 inscribed on a stone slab near Caesarea in modern Israel.

All four Gospels indicate that Jewish authorities manipulated Pilate in their desire to have Jesus crucified. Matthew is the only Gospel to report the famous scene



Detail of *The Maestà* (1308-1311), a tempera altarpiece on wood panel by Ducc[io di] Buoninsegna; Museo dell'Opera Metropolitana, Siena, Italy (SCALA/Art Resou[rce])

Pilate washed his hands to symbolize his refusal to accept re-sponsibility for the Crucifixion of Jesus.

of Pilate's washing his hands, saying: "I am innocent of the blood of this just person: see ye to it" (Matthew 27:24). The Gospel of Luke says that Pilate found out tha[t] Jesus was from Galilee and sent Him to Herod Antipas, the governor of Galilee, who was staying in Jerusalem [at] the time. Pilate apparently wanted to avoid having to make a decision about Jesus's fate. At one point in the trial, Pilate offered to release Jesus, probably because [he] was not convinced of Jesus's guilt.

Some traditions claim that Pilate died in A.D. 39 on th[e] orders of the Roman emperor Caligula, either by committing suicide or by execution. According to another tradition, he and his wife, Procla, became converts to Christianity. Procla is considered a saint in the Greek O[r]thodox Church, and both she and Pilate are saints in th[e] Ethiopian Orthodox Church. Richard A. Edwards

See also **Jesus Christ** (The trial); **Barabbas.**

Pile is a column used to support buildings, bridges, and other structures. Piles are often used to prevent buildings from sinking or collapsing. When the top layers of soil are too soft to support the foundation, piles are used to transfer the weight of the structure to a firmer layer of soil or rock. For some skyscrapers, piles may reach 200 feet (60 meters) below the surface. Piles may also be used to raise a structure above water or to support wharves. Piles may be made of wood, steel, or concrete. They are usually driven into the ground by a *pile driver,* a kind of hammer that drives the pile into po-sition by means of vibration and a weight. Piles also ma[y] be drilled into position or placed into predrilled holes. William E. Saul

See also **Breakwater; Building construction** (Foundations); **Cofferdam.**

Piles. See **Hemorrhoids.**

Pilgrimage. See **Religion** (Religious rituals; picture); **Islam** (The Five Pillars of Islam); **Architecture** (Romanesque architecture).



The Mayflower in Plymouth Harbor, an 1882 oil painting by William F. Halsall; Pilgrim Society, Plymouth, Mass.

The ***Mayflower*** brought the first Pilgrims from England to what is now Massachusetts, where they founded Plymouth Colony. The ship reached Plymouth Bay, *above,* on Dec. 26, 1620.

Pilgrims were the early English settlers of New England. The first group landed at what is now Plymouth, Mass., in 1620. The Pilgrims established Plymouth Colony along Cape Cod Bay.

The early Pilgrims included many *Separatists.* These people once belonged to the body of English Protestants known as *Puritans.* The Puritans wished to adopt reforms that would purify the Church of England, the nation's official church. The Separatists decided that they could not reform the church from within. They separated from the church and set up their own congregations.

In 1606, William Brewster helped form a small Separatist congregation in Scrooby, England. Separatist



Pilgrims Going to Church, oil on canvas, New-York Historical Society, New York City, Robert L. Stuart Collection

The Pilgrims walked to church in groups for protection. Most of the men carried muskets to guard against attacks by Indians. A preacher with his Bible is near the center of the above picture, painted in 1867 by the American artist George H. Boughton.

groups were illegal in England, and in 1607 the Scrooby congregation tried to flee to Amsterdam, Holland, to avoid arrest. They were caught, but most of them left England the next year. In 1609, the congregation settled in the Dutch town of Leiden.

After several years in Holland, some Separatists began to fear that their children would be more Dutch than English. As foreigners, they could not buy land or work in skilled trades. In addition, war had begun in Europe. The new land of America appealed to them. They offered to establish an English colony in America and found a group of English merchants willing to finance their expedition. In September 1620, 41 members of the Leiden congregation sailed for America on the ship *Mayflower,* along with 61 other English people. The group reached what is now Provincetown Harbor on Nov. 21, 1620. They explored the nearby coast and soon chose Plymouth as the site of their colony.

The term *Pilgrim* may have come from William Bradford, the second governor of Plymouth Colony. Bradford wrote that "they knew they were pilgrims" when they left Holland. However, for 200 years these people were known as "Founders" or "Forefathers," rather than "Pilgrims." Joan R. Gundersen

See also **Plymouth Colony; Colonial life in America; Bradford, William; Massachusetts** (picture: Plimoth Plantation in Plymouth); **Mayflower; Mayflower Compact.**

Additional resources

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Pilgrim's Progress. See **Bunyan, John.**

Pillory, *PIHL uhr ee,* was an instrument once used to punish people for minor offenses. It was a wooden framework with holes cut in it for the arms and head of the victims. They were locked into these holes for a certain length of time. The pillory stood in the public square. Prisoners suffered both because of their uncomfortable position and because passers-by jeered and often threw stones and rotten eggs at them. Often the prisoners' heads were shaved to increase their shame and embarrassment.

The English government used the pillory in the 1600's to punish certain writers and publishers. Daniel Defoe was subjected to the pillory for publishing a libelous essay. The Puritans brought the pillory with them to New England and used it to punish "notorious drunkards, scolds, and bawds." Marvin E. Wolfgang

See also **Stocks.**

Pilot. See **Airplane; Ship** (Navigating a ship).

Pilot, Automatic. See **Automatic flight control system.**

Pilot International is a service organization of business and professional leaders. The organization has about 19,000 members in more than 600 clubs in the United States, Canada, the Bahamas, Bermuda, Japan, and the United Kingdom. Pilot clubs sponsor activities to improve the civic, social, industrial, and commercial welfare of communities. Pilot International also sponsors a youth organization—Anchor Club for high school students.

Pilot International was founded in 1921 in Macon, Georgia. In 1975, the organization established the Pilot International Foundation to improve the lives of people with disabilities. A special focus for the foundation is helping people with brain disorders. Pilot International has its headquarters in Macon.

Critically reviewed by Pilot International

Pilot whale is one of the largest members of the dolphin family. The animal may grow 14 to 21 feet (4 to 6 meters) long and weigh $\frac{3}{4}$ to $2\frac{1}{2}$ tons (0.7 to 2.3 metric tons). A pilot whale is black, with a white streak down its underside. Its head has an organ called a *melon* that is made of fatty tissue. The melon helps the animal locate objects in the water (see **Dolphin** [The bodies of dolphins]).

Pilot whales swim in groups called schools. Large numbers of pilot whales often strand themselves on beaches. Scientists, however, are not certain what causes this behavior. Pilot whales are sometimes called *blackfish,* a name that also refers to various kinds of true fish and to the killer whale (see **Killer whale**).

John K. B. Ford

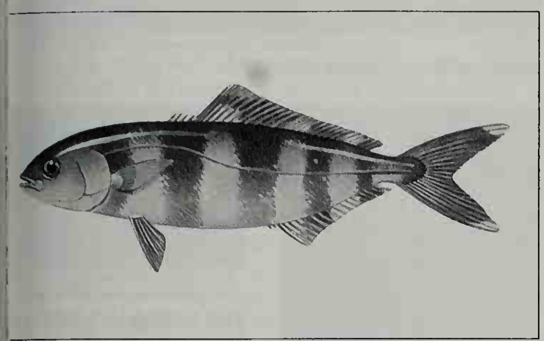
Scientific classification. Pilot whales make up the genus *Globicephala* in the dolphin family, Delphinidae.

Pilotfish is a kind of fish found near the surface in most tropical seas and the warmer temperate seas. It can also be found off the coasts of the Americas from Cape Cod to Brazil. Most pilotfish are approximately 1 foot (30 centimeters) long. They are white to bluish-white with five or six dark vertical bands. The pilotfish got its name because it follows ships, sharks, turtles,



Bettmann Archive

A pillory locked the arms and head of a person between two wooden boards. Another device, the *stocks,* held a person's legs. The pillory and stocks were used in the American Colonies to punish people who committed minor offenses.


WORLD BOOK illustration by Colin Newman, Linden Artists Ltd.
he pilotfish is a small sea fish that has five or six dark vertical ınds. The fish gets its name because it follows ships and ıarks, possibly in search of food.

ıd other large moving objects. William N. Eschmeyer

Scientific classification. The pilotfish is a member of the ımpano family, Carangidae. It is *Naucrates ductor.*

iłsudski, *peel SOOT skee,* **Józef,** *YOO zehf* (1867-935), a Polish patriot, led a movement to liberate Poland om Russia and helped unite his country. Piłsudski was ɔland's first head of state and military commander in ıief after the country achieved independence in 1918.

Poland's new democratic constitution of 1921 providǀd for a weak presidency. Piłsudski refused to run for e office. He withdrew from politics, and he resigned head of the military in 1923. But in 1926 he led a miliry overthrow of the government. He became premier ıd served until 1928. In 1930, he became premier again. om 1926 until his death, however, Piłsudski kept the al power of the government in his own hands.

Piłsudski was born on Dec. 5, 1867, near Vilnius, now Lithuania. He became a professional revolutionary in s youth. In 1887, he was arrested by the Russians and iled to Siberia for plotting to kill Russian Czar Alexaner III. But Piłsudski was not involved in the plot. After s release in 1892, he joined the new Polish Socialist ırty. In 1894, he became editor of the party's illegal ewspaper *Robotnik (The Worker).* The Russians arrestl him again in 1900 and sent him to an insane asylum hen he pretended to be insane. He escaped in 1901.

During World War I (1914-1918), Piłsudski fought at e head of the Polish Legions he had organized and ald with Germany and Austria-Hungary. In 1917, the ermans arrested him after he ordered his troops to fuse an oath of loyalty to the German and Austrian aries. Piłsudski was imprisoned until the end of the war.

After the collapse of Germany and Austria-Hungary in e war, Piłsudski became a national hero and headed e Polish provisional government. Later, as chief of ıte and military commander in chief, he led an armed uggle against Russia to establish Poland's borders. In s last years, he increased the presidential powers and nited those of parliament. John J. Kulczycki

ltdown hoax was a great deception in the study of ehistoric people. Between 1908 and 1912, parts of a ull and of a jawbone were found in a gravel pit at Piltwn in Sussex, England. Some scientists believed the mains came from a form of human being who lived 0,000 years ago. Others disagreed. But Piltdown "fos-" became famous as a "missing link" between physically modern human beings and the apes.

After years of controversy, scientists used newly developed chemical tests on the remains. They learned that the jaw came from a modern ape and that the human skull was much younger than the gravel in which it had been found. In 1955, radiocarbon tests dated the skull at A.D. 1230. Apparently, a prankster had buried an orangutan's jaw and a skull from a medieval cemetery. The jaw had been stained to make it look old and the teeth filed to make them look human. Karl W. Butzer

Pima Indians, *PEE muh,* are an agricultural people who live along the Gila and Salt rivers in southern Arizona. Since ancient times, the Pima and their ancestors have used the water from these rivers to irrigate their fields. The Pima call themselves *Akimuhli Au'autam,* which means *River People.*

The Pima are descended from the Hohokam, a farming people who dug long irrigation canals to bring water to their crops. The Hohokam also were wealthy traders and skilled craftworkers. After the Spaniards came to the New World, they spread Old World diseases that destroyed most Hohokam communities during the 1500's. The Hohokam Pima National Monument includes the remains of a Hohokam settlement.

The Pima added wheat and other crops brought by Europeans to those raised by the Hohokam. The Pima were powerful warriors and organized mounted patrols to protect their farms from Apache raiders. The Pima helped many white settlers. During the California gold rush of 1849, Pima warriors shielded the gold seekers crossing their territory. The Pima also sold supplies to wagon trains, served as scouts for the U.S. Army, and guarded white farmers from attacks by other tribes. But the whites took scarce river water and used it for their own fields. The loss of water ruined many crops and drove many of the Pima into poverty.

According to the 2000 U.S. census, there are about 8,500 Pima. Many live on the Gila River and Salt River reservations near Phoenix. Many work as farmers or unskilled laborers. An elected council governs each reservation. Henry F. Dobyns

Pimento, *puh MEHN toh,* is the popular name of a small evergreen tree of the myrtle family. A spice known as allspice, Jamaica pepper, or pimento comes from this tree. This spice is most commonly used for making pickles and baked goods, and for preserving meat products. The red fleshy pimento used to stuff green olives does not come from the pimento tree. That condiment, which is also known as red pepper or capsicum, is the fruit of a plant called capsicum.


WORLD BOOK illustration by John D. Dawson
The pimento bears small berries used to make the spice called *allspice, Jamaica pepper,* or *pimento.*

The name of the pimento tree comes from *pimienta,* the Spanish word for peppercorns. The tree is native to the West Indies and to Central Amer-

ica. Most commercial pimento spice comes from Jamaica.

Most pimento trees grow to a height of 20 to 30 feet (6 to 9 meters). The slender, upright trunk of the pimento is covered with smooth gray bark. The shiny, oval leaves have a pleasant odor when fresh. The fruit is a small berry about the size of a black currant. It is dark brown or black, glossy, sweet, and juicy when ripe. The dried, green unripe berry is used for the commercial spice.

Scientific classification. The pimento is in the myrtle family, Myrtaceae. It is *Pimenta dioica.* David S. Seigler

See also **Allspice.**

Pimpernel, *PIHM puhr nehl,* is a small annual plant that grows wild in Europe and Asia. It is sometimes planted in flower gardens of North America and often runs wild. The plant is low and spreading, with oval leaves in pairs on the stem. The small, bell-shaped flowers grow along the stem. There are several varieties, with red, scarlet, blue, or white flowers. Another name for the pimpernel is *poor-man's weatherglass.* This name refers to the flowers' habit of closing at the approach of cloudy or rainy weather.

Scientific classification. The pimpernel belongs to the primrose family, Primulaceae. It is classified as *Anagallis arvensis.* James S. Miller

Pimple is a red, raised skin blemish that usually contains pus. The most common cause of pimples is *acne,* a skin disorder that frequently occurs among teen-agers.

Acne consists of various kinds of blemishes that appear on the face, upper chest, and back. It is caused by hormone changes during the teen years. One kind of hormone stimulates the oil glands, which then grow larger and produce much oil. The *pores* (openings) of the oil glands at the skin surface are easily plugged, and oil accumulates under the plugs. A plugged pore forms a blemish called a *blackhead* or *whitehead.* Pimples are caused by the *acne bacillus,* a germ that thrives in the backed-up oil. The germ makes irritating substances from the oil, causing redness and pus. Mild acne can be treated by washing affected areas regularly and using such nonprescription medicines as benzoyl peroxide. Severe acne should be treated by a doctor. Pimples should not be squeezed. Squeezing may cause scarring.

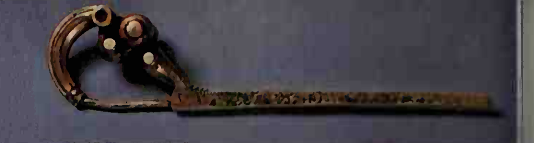
Other causes of pimples include infections by *staphylococcal* and *streptococcal* bacteria. Unlike acne, in which there are many blemishes, these infections usually start with one pimple. This pimple may develop into a boil. Doctors treat these infections with antibiotics.

Many black men with curly facial hair develop pimples where they shave. These painful "shaving bumps" occur because the coarse, curved whiskers tend to grow into the skin after shaving. Growing a beard relieves this condition. Yelva Liptzin Lynfield

See also **Acne.**

Pin is a short, pointed piece of metal. Pins are used mainly to hold two or more pieces of material together. People also wear pins as jewelry.

There are many kinds of pins. The most common types are *straight pins* and *safety pins.* These pins are usually made of steel or brass. Straight pins have a flat head at one end and a point at the other end. Straight pins are used primarily by seamstresses and tailors to fasten patterns to fabrics and to hold layers together before they are sewn. Safety pins have an oval shape. The point of the pin snaps into a protective guard to prevent the pin from falling out of the fabric and to avoid injuries. Safety pins are used mainly as temporary fasteners.


Gold and jeweled fibula; Pigorini Museum, Rome (SCALA/Art Resou
Etruscan fibula (500's or 400's B.C.)


Chicago Historical Society (WORLD BOOK photo by Dan Miller)
Man's stickpin (Late 1800's)


Silver brooch with gilding and red ena National Museum of Ireland (Lee Boltin
Irish brooch (A.D. 800's)


Chicago Historical Society (WORLD BOOK photo by Dan Mil
Brooch (Mid-1900's)

Various types of pins have been produced through the centuries, but their chief uses have remained unchanged. Pins are still used for decoration and to hold pieces of material together.

Pins were one of the earliest types of jewelry. People began wearing pins at least 20,000 years ago. Prehistoric people made pins from splinters of bones, wood, and thorns. Later pins were formed out of iron and bronze. The ancient Greeks and Romans used pins called *fibulae,* which resembled modern safety pins, to hold their garments together. Through the years, various types of decorative pins have been developed. For example, large ornamental pins called *brooches* were popular in the 1800's. At that time, women wore them at the center of the bust, but today they use them to adorn their coat lapels. Straight pins known as *stickpins* were originally used in the 1800's and early 1900's to hold men's ties and cravats in place. Today, these pins, which have gems, initials, or emblems of organizations at the top, are worn by women as accessories on scarfs and lapels.

Pins were handmade until the early 1830's. In 1832, the American inventor John Ireland Howe patented one of the first practical machines for manufacturing pins. In 1849, Walter Hunt, another American inventor, patented a design that served as the basis for modern safety pins. Lois M. Gurel

See also **Etruscans** (picture: Etruscan jewelry); **Shell** (picture: A butterfly pin).

Piñata. See **Christmas** (In Latin America; picture); **Mexico** (Holidays).

Pinchback, P. B. S. (1837-1921), was an American politician. In 1872, he became the first black to serve as governor of a state of the United States. Pinchback, a Republican, had become lieutenant governor of Louisiana in 1871. He served as acting governor for six weeks in 1872 and 1873 following the impeachment of Governor Henry C. Warmoth.

Pinchback won election to the United States House of epresentatives in 1872 and to the United States Senate 1873. His opponents charged that laws had been vioted in both of the elections. Both the House and the enate denied Pinchback membership, though white ouisiana officials who were chosen by the same proceures were declared legally elected. From 1870 to 1881, inchback published a weekly newspaper, *The* (New Orans) *Louisianian.*

Pinckney Benton Stewart Pinchback was born in lacon, Ga. His mother, a former slave, had been freed y his father, a wealthy white planter. Otey M. Scruggs

inching bug. See Stag beetle.

inchot, *PIHN shoh,* **Gifford** (1865-1946), an American onservationist and politician, was one of the first govrnment leaders to promote the scientific management f forests in the United States. In 1898, President Theoore Roosevelt appointed him chief of the Division of orestry, which became the U.S. Forest Service in 1905. nchot led the Forest Service until 1910. At the urging f Pinchot and others, Roosevelt greatly expanded the ation's forest reserves. In 1908, Pinchot became chairan of the National Conservation Commission, which ade the first inventory of the nation's natural reurces. Pinchot also served as governor of Pennsylvaa, from 1923 to 1927 and from 1931 to 1935.

Pinchot was born in Simsbury, Conn., and graduated om Yale University in 1889. He studied forestry in ance and other European countries. Pinchot wrote *The ght for Conservation* (1910). Robert W. Cherny

See also Taft, William Howard (Legislative defeats).

inckney, Charles (1757-1824), was a South Carolina gner of the Constitution of the United States. At the je of 29, he was one of the youngest delegates at the onstitutional Convention of 1787. Pinckney submitted s own plan for a new federal government. The plan as not adopted, but at least 30 of his suggestions were cluded in the final version of the Constitution.

Pinckney was born into a prominent plantation family Charleston, S.C. He was educated in Charleston and ter practiced law there. Pinckney became a lieutenant the Revolutionary War in America (1775-1783). The itish captured him in the fall of Charleston in 1780 and pt him imprisoned until 1781. From 1784 to 1787, nckney was a delegate to the Congress of the Confedation. He won election as governor of South Carolina ur times, serving from 1789 to 1792, from 1796 to 1798, d from 1806 to 1808. Pinckney was a U.S. senator from 98 to 1801 and a U.S. representative from 1819 to 1821. e served as U.S. minister to Spain from 1801 to 1805. s cousin Charles Cotesworth Pinckney also signed the onstitution. W. Calvin Smith

nckney, Charles Cotesworth (1746-1825), a anter, politician, and diplomat, was a South Carolina gner of the Constitution of the United States. An influtial delegate at the Constitutional Convention of 1787, nckney supported a strong national government and e power of the Senate to *ratify* (approve) treaties. He o helped settle the dispute between the Northern and uthern states over regulation of the foreign slave de (see **Constitution of the United States** [The mpromises]). He later helped win ratification of the nstitution by South Carolina. Pinckney's cousin arles Pinckney was also a signer of the Constitution.

Pinckney was born in Charleston, S.C. He was educated in Britain and France, but returned to South Carolina to practice law. During the Revolutionary War in America (1775-1783), he rose to the rank of brigadier general. He was taken prisoner when the British captured Charleston in 1780, and was held for two years.

In 1796, Pinckney accepted a position as U.S. minister to France. But the French refused to receive him. The next year, President John Adams appointed Pinckney as one of three special commissioners to resolve differences between the United States and France. French negotiating agents demanded a loan to France and a bribe for the French statesman Prince Talleyrand. Pinckney's reply to their demands was "No! No! Not a sixpence!" This negotiation attempt came to be known as the *XYZ Affair* (see **XYZ Affair**).

Pinckney ran as a Federalist candidate in three presidential elections. He lost to Thomas Jefferson in 1800 and 1804 and to James Madison in 1808. W. Calvin Smith

Pinckney, Elizabeth Lucas (1722-1793), a colonial planter of South Carolina, did much to promote the economic growth of South Carolina in the 1700's. She successfully developed and grew indigo plants on her father's plantations. The blue dye produced from the plant was in great demand in Europe. Pinckney shared her knowledge with other South Carolina farmers and helped indigo become a leading export for the colony.

Pinckney was probably born in Antigua, then a British colony in the West Indies. Her father, George Lucas, served as the lieutenant governor there. In 1738, Lucas brought his family to South Carolina, where he had inherited three plantations near Charleston. The next year, he returned to Antigua, leaving Elizabeth, then 16 years old, in charge of the plantations. In 1744, Elizabeth married Charles Pinckney, a planter and lawyer. Among their children were two future statesmen, Charles Cotesworth Pinckney and Thomas Pinckney. After Elizabeth's husband died in 1758, she successfully managed the Carolina plantations for the next 35 years. She died in Philadelphia. President George Washington, who had met her on a tour of the South in 1791, served as a pallbearer at his own request. W. Calvin Smith

Pinckney, Thomas (1750-1828), was an American soldier, statesman, and diplomat. He arranged the Treaty of San Lorenzo, also known as the *Pinckney Treaty,* with Spain in 1795 (see **Pinckney Treaty**). He ran as a Federalist candidate in the presidential election of 1796, which was won by John Adams.

Pinckney was born in Charleston, S.C., and educated in Britain and France. He fought in the Revolutionary War in America from 1775 to 1781, and rose to the rank of major. Pinckney was governor of South Carolina from 1787 to 1789 and became the U.S. minister to Great Britain in 1792. He was a U. S. representative from 1797 to 1801. His brother Charles Cotesworth Pinckney and his cousin Charles Pinckney were signers of the Constitution of the United States. W. Calvin Smith

Pinckney Treaty was an agreement ending disputes between the United States and Spain over possession of the Florida area and the mouth of the Mississippi River. The treaty, whose formal name was the Treaty of San Lorenzo, was signed on Oct. 27, 1795. Spain recognized the 31st parallel, the northern border of Florida, as the southern boundary of the United States. Spain agreed to

let Americans land goods at New Orleans free of taxes for a period of three years. The two nations also agreed that this right could be renewed. Both nations gained free use of the Mississippi. Donna J. Spindel

Pindar, *PIHN duhr* (522?-443 B.C.), was the greatest lyric poet of ancient Greece. He is generally credited with inventing the Pindaric ode. This type of ode is built of three stanzas—the *strophe, antistrophe,* and *epode*—repeated in series. Pindar wrote these stately, intricate poems in praise of various events, such as an athletic victory at the great national games.

Pindar's odes were intended for elaborate performance, with music and dance, when the victor returned to his native city. They are unlike other poetry, except for some choral lyrics in the tragedies of the dramatist Aeschylus. Standard elements include praise of the victor, often combined with veiled advice; the telling of a myth; and praise of the gods. The odes are perfect in form and beautiful in their intricate language, but lose much in translation. Most of Pindar's other poetry was lost.

Pindar was born of a noble family in Cynoscephalae near Thebes. His fame was so great that when Alexander the Great burned Thebes to the ground, Pindar's house was the only one spared. Pindar was a deeply religious man who wrote of the immortality of the soul and judgment by the gods after death. In politics, he was conservative and antidemocratic. Cynthia W. Shelmerdine

Pindus Mountains. See Greece (The land).

Pine is any of a large group of evergreen trees that have needlelike leaves and bear cones. There are about 100 species of pines. Almost all of them grow naturally only in the Northern Hemisphere. Pines are found in a wide range of environments, but they most often grow in sandy or rocky soils. They are especially common in the mountains of western and southeastern North America, southern Europe, and southeastern Asia. Some pines reach heights of about 200 feet (61 meters). Others are small and shrublike.

Pines belong to a group of plants called *conifers.* All conifers reproduce by means of cones that produce pollen and seeds. A pine differs from other conifers in the way its leaves grow. Nearly all pines have needles that grow in bundles of two, three, or five each. The leaves of other conifers grow in larger bundles or do not form bundles. Conifers closely related to pines include firs, larches, and spruces.

Pine trees bear both male and female cones. The male cones typically measure less than 1 inch (2.5 centimeters) in length. The female cones are much larger and have woody scales. When people speak of "pine cones," they usually are referring to the female cones. In the spring, the male cones produce enormous quantities of pollen. The wind carries the pollen to egg cells attached to the scales of the female cones. The pollen fertilizes the egg cells, which then develop into seeds. The seeds take one or two years to mature. The mature seeds of most pines have winglike parts that cause the seeds to twirl and float in the wind. Pine seeds may blow as far as 300 feet (91 meters) from the parent tree.

Pines rank as the world's most important source of timber. Most pines grow rapidly and form straight, tall trunks that are ideal for lumber. Some pines produce *resin,* a substance used to make such products as turpentine, paint, and soap. The wood of many pine species makes excellent pulp for the manufacture of pape[r]. Pines are also grown as shade trees.

North American pines

About 65 species of pines are native to North America. Thirty-six of them grow in the United States. Botanists divide pines into two groups: (1) soft pines and (2) hard pines. The trees of these groups differ mainly in the way their needles grow.

Soft pines, also called *white pines,* typically produce needles in bundles of five. Hard pines, also known as *yellow pines,* ordinarily produce needles in bundles of two or three. In addition, hard pines generally have heavier, harder wood than soft pines.

Both hard and soft pines grow naturally in areas throughout North America. This article divides North American pines into three groups: (1) eastern pines, (2) southeastern pines, and (3) western pines.

Eastern pines. The *eastern white pine* is the only so[ft] pine native to eastern North America. It is common in New England and grows as far west as Minnesota and as far south as northern Georgia. This huge, majestic tree may reach a height of over 100 feet (30 meters) and measure more than 4 feet (1.2 meters) in diameter at its base. It has long, slender cones and is prized for its white, smooth-grained lumber.

Two important hard pines that grow in Canada and the northeastern part of the United States are the *red pine* and the *jack pine.* The red pine is found in areas near the Great Lakes, in New England, and in southeastern Canada. It gets its name from its reddish-brown bark. It has long needles that grow in bundles of two and is an important timber tree. The jack pine grows chiefly in sandy soils from the northern Great Lakes region to northwestern Canada. Its needles grow in bundles of two and it bears small, curved cones. The cones may remain closed and hold their seeds for many year[s]. The jack pine is often one of the first trees to grow afte[r] wildfires. The heat of such fires causes the cones to open, releasing the seeds that produce new trees. The wood of the jack pine is used for paper pulp.

The *pitch pine* grows in sandy soils in New England and in shallow soils in the southern Appalachian Mour[n]tains. Its cones are spiny and measure about 4 inches ([1]0 centimeters) long. Its needles grow in bundles of three.

Southeastern pines. Pines grow throughout the Southeastern United States. The *Virginia pine* is found [in] the southern Appalachian Mountains and the rolling hills of the Piedmont Region. It has scaly bark, and its cones measure about 2 inches (5 centimeters) in length. Its needles grow in bundles of two. The *shortleaf pine* grows in the same area as the Virginia pine but is a much taller tree. It may reach a height of over 100 feet (30 meters). Its bark is divided into irregular plates, and its needles grow in bundles of two or three. The *loblol[ly] pine* thrives in many environments throughout the Southeast. It resembles the shortleaf pine, but its needles always grow in bundles of three. These three pines all grow rapidly and are common in abandoned fields and pastures. All are important sources of lumber.

Many pine species grow in the sandy soils of the Atlantic and Gulf coastal plains. The *longleaf pine* grows [in] particularly sandy soils. It has large cones and extreme[ly] long needles that may reach a length of 18 inches (46



Josef Muench

A forest of pine trees is a place of unusual beauty. This photograph shows a forest of ponderosa pines in the San Francisco Mountains of Arizona. In the foreground, pine cones lie on the snow-covered forest floor.

ntimeters). The *slash pine* grows in somewhat moister ils. Its needles and cones are smaller than those of the ngleaf pine. Both species are important sources of nber and resin. The *pond pine* grows in swampy eas. It can grow back from its roots after the above-ound part of the tree has been destroyed by fire.

Western pines. Many species of pines grow in the ountains of western North America. Different species e found at different elevations. The *Digger pine* grows lower elevations in the Sierra Nevada and in the Coast nges of California. This tree has needles that grow in ndles of three and cones that may measure as much 10 inches (25 centimeters) in length. Digger pine eds were once an important food for Indians.

A number of important pines grow at slightly higher evations than the digger pine. The *ponderosa pine* is mmon throughout the Rocky Mountains and the east- side of the Cascades, and in the Southwestern ited States. This hard pine grows up to 130 feet (40 ters) tall and produces high-quality lumber. Its nee-s grow in bundles of three, and its cones are about 5 inches (13 centimeters) long. The *sugar pine* and the *western white pine* are found at middle elevations in the Sierra Nevada. The sugar pine produces the longest cones of any North American pine. They may reach nearly 30 inches (76 centimeters) in length. The *lodgepole pine* grows at higher elevations than the ponderosa pine in the Sierra Nevada and the Rocky Mountains. It thrives in sandy soils and its needles grow in bundles of two. Its small cones may remain closed for years after they mature, and its seeds are released in wildfires.

The *limber pine* and the *whitebark pine* are found in the Rocky Mountains at some of the highest elevations at which trees can grow. In areas exposed to strong winds and extreme cold, these two soft pines grow to only about 5 feet (1.5 meters) in height. Elsewhere, they grow 30 to 50 feet (9 to 15 meters) tall. Another soft pine found at extremely high elevations is the *bristlecone pine.* Some are among the oldest living things. A number have lived over 4,000 years. See **Bristlecone pine.**

Several species of pines grow naturally only in small

areas of southern California. For example, the *Monterey pine* is native to a small area on the California coast. In this area, its wood has little commercial value. However, this tree has been introduced into the Southern Hemisphere and now ranks as a major source of timber in Australia, Chile, New Zealand, and South Africa.

Other pines

Only a few pine species grow in northern Europe. The *Scotch pine*, a valuable timber tree, is probably the most important of these. This pine also is grown in many areas of North America, where it is widely used as a Christmas tree.

Many species of pines grow in the countries that border the Mediterranean Sea. The *black pine*, also called the *Austrian pine*, is an important source of timber in this region. It also is cultivated worldwide as an ornamental tree. The *Aleppo pine* is the most widespread pine of the Mediterranean region. It grows from Spain and northern Africa near the Strait of Gibraltar to the mountains of Israel and Lebanon.

About 15 pine species grow naturally in southeastern Asia and Japan. Most of them grow in mountainous areas. In northern Asia, the Siberian pine ranks as an important pine species. This pine grows from the Ural Mountains through western and central Siberia to northern Mongolia. Norman L. Christensen, Jr.

Scientific classification. Pines are in the pine family, Pinaceae. They make up the genus *pinus*.

Related articles in *World Book* include:

Cell (picture: Pine needle cells)
Conifer

Some pines of North America About 65 species of pines grow naturally in North America. Most of them thrive in rocky or sandy soils. They are especially common in mountainous areas. Six species of North American pines are illustrated below. The drawings include examples of the needles and cones of each species.

WORLD BOOK illustrations by James Te



The eastern white pine ranges from New England to Minnesota. It has a tall, straight trunk and slender cones.



The jack pine grows from the Great Lakes region to northwestern Canada. Its cones are curved and tightly closed.



The loblolly pine is found in the South eastern United States. Its needles grow in bundles of three.



The longleaf pine grows on the Atlantic and Gulf coastal plains. It has extremely long needles.



The bristlecone pine is found at high elevations in the Rocky Mountains. Its needles grow in bundles of five.



The ponderosa pine is common in the mountains of western North America. This tree produces excellent lumber.



Horticultural Photography

Te **Scotch pine** is one of the few pine species native to north- Europe. This valuable timber tree also is raised in North erica for use as a Christmas tree.

(rant
Ergreen
Gnnosperm
Lf (picture: Vein patterns)
Lnber (Softwood lumber)
Fer (How paper is made)
Fon

Plant (Sexual reproduction; diagram: How conifers reproduce; pictures)
Resin
Rosin
Seed (picture: How seeds sprout)
Tree (pictures)
Turpentine

ne siskin is a small finch that lives in North America. ats the seeds from the cones of evergreen trees. The e siskin is about 5 inches (13 centimeters) long and is ored gray and brown. It has yellow markings on its igs and tail that can be seen most clearly when it is ng. The pine siskin breeds in mountain areas of Can- a and the Northeastern ited States. It migrates, not to the same place h year.

The pine siskin may nd the winter almost where in the United tes or Mexico. The bird ally nests in evergreen es, and makes its nest of gs, roots, plant bark, l hair. The pine siskin three or four pale en or bluish eggs ked with reddish- wn spots.

cientific classification. pine siskin is a member of finch family, Fringillidae. It assified as *Carduelis pinus*.

ndra L. Vehrencamp



© Calvin Larsen, Photo Researchers

Pine siskin

Pine-tree shilling was a silver coin minted by colonists in Boston, in the Massachusetts Bay Colony, from 1667 to 1682. A pine tree encircled by the word *Masathusets* appeared on one side of the coin. The other side bore the Roman numeral *XII* and the date *1652*. The XII stood for twelve pence, which equaled one shilling. The date 1652 was probably used so that the colonists could claim the coins were minted legally. Under English law, only the monarch was allowed to issue coins. However, King Charles I had been executed in 1649, and Charles II did not succeed him until 1660 (see **England** [History]). Thus, the colonists could claim the coins were minted at a time when royal authority did not exist.





WORLD BOOK photo by James Simek

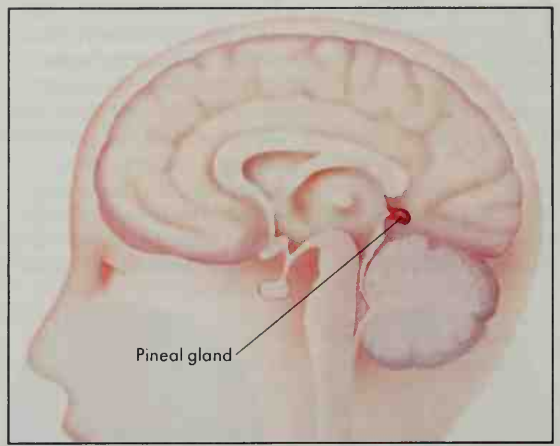
The pine-tree shilling was a colonial silver coin. It had a pine tree on one side and the date 1652 on the other side.

The pine-tree shilling was also called the *Boston shilling* and the *Bay shilling*. Three-penny and six-penny pieces made during the same period bore the same design. R. G. Doty

Pineal gland, *PIHN ee uhl,* also called *pineal body,* is a tiny organ in the brain of human beings and most other *vertebrates* (animals with a backbone). Scientists are uncertain of the function of the pineal gland in human beings. They believe it plays a role in a variety of important body functions, including certain reproductive processes. In most other vertebrates, the pineal gland helps regulate certain daily and seasonal body cycles.

The pineal gland secretes a hormone called *melatonin.* Its production of melatonin varies with periods of light and darkness in the environment. In most amphibians, birds, fishes, and reptiles, the gland is located in the back of the head just beneath the skin. It responds directly to light that penetrates the skin. In mammals, including human beings, the pineal gland lies near the center of the brain. It obtains information about light in the environment by means of nerve pathways originating in the eyes. In general, light slows and darkness stimulates the pineal gland's production of melatonin. Therefore, the gland tends to secrete small amounts of melatonin during the day and large amounts at night.

In most vertebrates, the pineal gland's secretion of melatonin keeps the animal "timed" to its environment. Most animals live under conditions where the daylength and the temperature of the environment change throughout the year. To survive, they must breed at certain times of the year, usually spring or early summer. The offspring will then have a chance to grow strong enough to survive the first winter. The pineal gland keeps track of the changing daylengths. By means of its melatonin, it sends this information to the body and



WORLD BOOK illustration by Charles Wellek

The pineal gland is located near the center of the brain in human beings. It secretes *melatonin,* a hormone believed to play an important role in a person's sexual development.

appropriate reproductive responses are made.

In human beings, melatonin has been linked to the onset of *puberty,* the stage of life when a person matures sexually. Studies have shown that the pineal gland's nightly secretion of melatonin decreases when a boy or girl reaches puberty. Other studies have indicated that melatonin may help regulate menstrual cycles in women and sperm production in men. In addition, researchers have suggested a connection between melatonin levels and certain mental illnesses. Russel J. Reiter

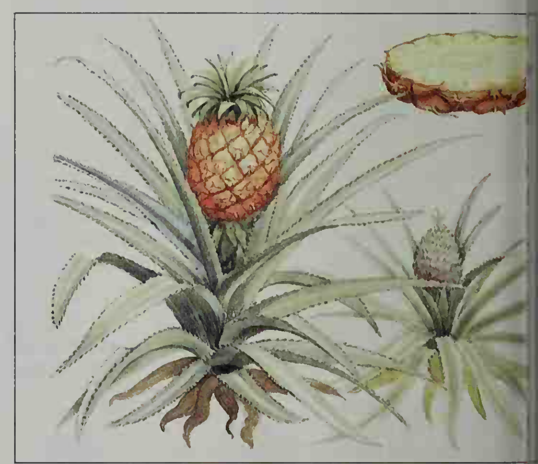
Pineapple is a tropical plant known for its juicy, fragrant fruit. It probably received its name because the fruit looks like a large pine cone. Many people enjoy drinking the juice of the pineapple and eating the fruit as a dessert or in salads. Thailand grows more pineapples than any other country. Farmers there produce about one-fourth of the world's pineapples.

The pineapple plant grows from 2 to 3 feet (61 to 91 centimeters) tall, and the fruit weighs from 4 to 8 pounds (2 to 4 kilograms). The ripe fruit has a greenish-orange, yellowish-green, or dark green *shell* (skin). At the top of the fruit is a group of small leaves called the *crown.* The flesh of the fruit, the part eaten by people, is firm and pale yellow, though it may be white. The most widely grown kind of pineapple, *Smooth Cayenne,* is seedless, but some varieties have small brown seeds beneath the shell.

A pineapple plant has blue-green, sword-shaped leaves that grow around a thick stem. The edges of the leaves of most varieties of pineapples have sharp spines. But the leaves of the *Smooth Cayenne* have spines only at the tips and bases. The pineapple plant has underground roots and small roots that grow aboveground.

When the plant is from 14 to 16 months old, an *inflorescence* (flower stalk with tiny flowers attached) appears in the center. The inflorescence resembles a small pink-red cone. After the inflorescence has grown about 2 inches (5 centimeters) high, blue-violet flowers begin to open. Each flower blooms for only one day. All the flowers open within 20 to 30 days. Each flower develops into a fruitlet. The fleshy parts of the fruitlets unite with the stalk to which they were attached. This combination of fruitlets is called a *multiple fruit.* The multiple fruit and the stalk forms the yellow center of the pineapple. The pineapple's shell develops from thick, hard, leaflike structures called *floral bracts.*

Cultivation and production. Pineapple plants need a warm climate and well-drained soil. Too much water can harm them, but irrigation is necessary in some dry regions. Before planting, pineapple growers plow the land deeply and break it up well. In Hawaii and some other regions, they use a machine to put certain chemicals into the soil to kill harmful roundworms called *nematodes.* The same machine also deposits fertilizer and lays wide strips of plastic on the ground. The plastic strips keep the chemicals from escaping from the soil. The plastic also conserves moisture, keeps the soil



WORLD BOOK illustration by Kate Lloyd-Jones, Linden Artists

The pineapple plant has sword-shaped leaves. Large leaves grow from the stem, and smaller ones grow from the fruit.



Bruce Coleman

The pineapple fruit has tangy, juicy flesh. The thick, hard skin may be greenish-orange, yellowish-green, or dark green.

ırm, and discourages the growth of weeds.

Pineapples are grown from any of four parts of a neapple plant: (1) *shoots,* (2) *slips,* (3) *crowns,* and (4) *ckers.* Shoots grow from the main stem. Slips grow om the flower stalk just below the fruit. Crowns are the oups of leaves at the top of the pineapple. Suckers se from the roots below ground.

Workers insert the shoots, slips, crowns, or suckers ough the plastic strips by hand. They punch holes in e plastic with a planting tool. After planting, pineapple ınts require careful cultivation. Growers may use hor-onelike chemicals to make the plants flower and pro-ce fruit faster than they would naturally. Machines do ost of the weeding, spraying, and fertilizing that used be done by hand. About 20 months after planting, the ıeapples are ready to be picked. A pineapple plant ars one fruit for the first harvest and may bear two its for the second or third harvest. Most planters re-ınt fields after every two or three harvests.

In most countries, pineapples are harvested by hand. ıeapple pickers grab the fruit by the crown and twist rom the stalk. They put the pineapples in baskets apped to their backs or in canvas bags carried over shoulder. Hawaiian pineapple growers use a *har-ster-conveyor* to simplify the fruit-picking. This ma-ne consists of a long *boom* (metal arm) with a convey-belt built into it. A truck moves the boom through the ıeapple field, with the boom extending over many vs of plants. Pineapple pickers walk behind the boom. ey pick the pineapples and drop them onto the con-vor belt, which carries them to the truck.

At the cannery, the pineapples are washed and sorted size. A machine called a *Ginaca* removes the shells, ıches out the cores, and cuts off the ends of the eapples. Next, the fruit is cut into slices or pieces. en it is put in cans, syrup is added, and the cans are led. The unsweetened juice from the pineapple es is also canned. Finally, the cans are heated to kill microorganisms that might cause spoilage.

Pineapple plants also have several other uses. Various ts of the plant are used to make cattle feed, meat ten-izers, and medicines. In the Philippines, people ave the fibers of the plant into a cloth called *piña.*

History. Many scientists believe that pineapples origi-ed in Brazil. Christopher Columbus and his crew, o explored the West Indies in 1493, were probably first Europeans to taste the fruit. Europeans later nd pineapples throughout most of South and Central erica and the West Indies. They took the fruit to Eu-e and planted it in hothouses. It became a favorite t of royalty and the wealthy.

Commercial production of pineapples began in the -1800's in Australia, the Azores, and South Africa. To-the world's chief pineapple producers include zil, China, Côte d'Ivoire, Indonesia, Malaysia, Mexico, Philippines, South Africa, Thailand, and the United es. Plantations in Hawaii produce most pineapples are grown in the United States. Michael J. Tanabe

Scientific classification. The pineapple belongs to the neliad family, Bromeliaceae. Its scientific name is *Ananas co-us.*

ee also **Hawaii** (Agriculture); **Fruit** (table: Leading s in the United States).

P ero, *puh NEER oh,* **Arthur Wing** (1855-1934), was a skillful and highly productive English playwright. He became popular at first for comedies and later for "problem plays," in which he explored various social problems of his day. The problem plays helped pave the way for serious drama in England. Prior to 1910, Pinero's success in England rivaled that of his contemporary, George Bernard Shaw.

Pinero gained great popularity for the comedy *The Magistrate* (1885); *Dandy Dick* (1887), one of his many farces; and the sentimental romance *Sweet Lavender* (1888). Later hits included the sentimental comedy *Trelawny of the "Wells"* (1898) and *The Gay Lord Quex* (1899), one of his finest comedies. Pinero's most popular problem plays included *The Second Mrs. Tanqueray* (1893) and *His House in Order* (1906). His problem plays are now considered outdated, but theater companies occasionally revive his comedies. Pinero was born in London. King Edward VII knighted him in 1909, and he became known as Sir Arthur Pinero. Charles A. Berst

Ping-pong. See **Table tennis.**

Pink is a group of about 300 species of flowering plants that botanists have named *Dianthus,* the Greek word for *Jove's flower.* The blossoms of these flowers are often seen in shades of pink. But the name *pink,* according to many authorities, is used in the sense of *pierce,* or *puncture,* and refers to the crinkled edges of the petals. The group includes several favorite garden flowers admired for their beauty and delicate scent. The spicy fragrance of many old-fashioned gardens comes from clove pinks, clustered in their grasslike leaves and showing combinations of pink, white, and red. The cultivated pinks include the *carnation;* derivatives of the *common,* or *feather, pink; clove pinks; rainbow pinks;* small-flowered *maiden pinks;* and *sweet Williams,* or *bunch pinks.* Pinks are grown from seeds and cuttings. See also **Baby's-breath; Carnation; Sweet William.**

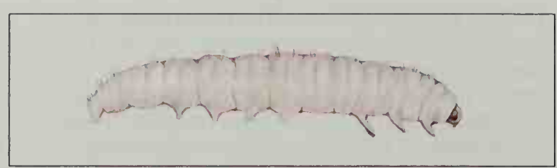
W. Dennis Clark

Scientific classification. Pinks belong to the pink family, Caryophyllaceae. The scientific name for the parent of the cultivated carnation is *Dianthus caryophyllus.* The common pink is *D. plumarius;* the rainbow pink, *D. chinensis;* the maiden pink, *D. deltoides;* the sweet William, *D. barbatus.*

Pink bollworm is an insect that attacks cotton plants in many parts of the world. The feeding of this insect reduces the yield and quality of cotton lint and the oil content of the seeds. Experts believe the pink bollworm was imported from Egypt into Mexico in 1911 in shipments of cotton seed. The insect was first discovered in the United States in Texas in 1917. Large sums of money have been spent in an effort to kill the pink bollworm in the United States.

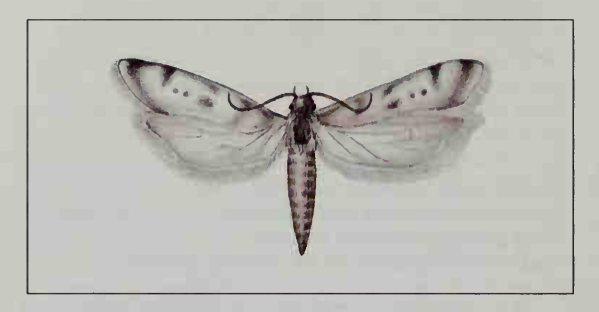
The adult is a small grayish-brown moth, with a wingspread of about $\frac{3}{5}$ inch (15 millimeters). The larva is about $\frac{1}{2}$ inch (13 millimeters) long. The eggs are laid on all parts of the cotton plant. When the larvae hatch, they feed on the pollen and fleshy parts of the flower. The infested flowers do not open normally, and many fall off. Later, the larvae enter the growing cotton bolls, eat the seeds, burrow through the lint, and interfere with the growth of the bolls. This causes the cotton to rot.

In spring and summer, the larvae mature in 8 to 16 days. Those hatched in fall and winter may remain as larvae from a few months to two years or more. When the summer larvae are grown, they leave the bolls. They



WORLD BOOK illustrations by Shirley Hooper, Oxford Illustrators Limited

The pink bollworm in the caterpillar stage, *above,* may seriously damage the blossoms and bolls of the cotton plant. The pink bollworm moth, *below,* is the adult form of the insect.



spend the third, or pupal, stage of their lives about 3 inches (8 centimeters) underground or under decaying leaves or other organic matter at the soil surface. The pupal period lasts from 6 to 20 days. The resting larvae mature in the ground or in the seed and lint inside the boll. The insect may be easily carried to any distance while in this resting larval stage. Breeding begins early in spring and continues until frost, with several generations produced in a season. John R. Meyer

Scientific classification. The pink cotton bollworm belongs to the gelechiid moth family, Gelechiidae. Its scientific name is *Pectinophora gossypiella.*

Pinkerton, Allan (1819-1884), an American detective, in 1850 established one of the first detective agencies in the United States. He first won fame for exposing the activities of a band of counterfeiters. In 1861, Pinkerton guarded Abraham Lincoln as he journeyed from Springfield, Illinois, to Washington, D.C., to be inaugurated as president. Soon after the outbreak of the American Civil War (1861-1865), Pinkerton helped organize a federal secret service. He also operated his own firm in Chicago, and established branches in several cities.

After the Civil War, Pinkerton organized groups of armed men known as "Pinkerton Men," whose services were available to employers at a daily fee. These forces broke labor strikes that occurred during the Reconstruction period. Members of labor unions hated the "Pinkerton Men" because these men were employed on the side of management against the unions.

Pinkerton also smashed several Western gangs. His earliest "Wild West" case ended with the capture of the Reno brothers, a gang of train robbers, in 1868.

Pinkerton was born on Aug. 25, 1819, in Glasgow, Scotland, and moved to the United States about 1842. In Illinois, he became deputy sheriff of Kane County and later of Cook County. His autobiographical writings include *Criminal Reminiscences and Detective Sketches* (1879) and *Thirty Years a Detective* (1884). James E. Sefton

Pinkeye. See Conjunctivitis.

Pinocchio. See Collodi, Carlo.

Pinochle, *PEE nuhk uhl* or *PEE nahk uhl,* is a card ga e played with a special deck consisting of 48 cards. Eac of the four suits has 12 cards, two each of every card from the nines through the aces. The aces are the hig est-ranking cards, followed by the tens, kings, queen jacks, and nines.

There are many variations of pinochle. One of the most popular forms of the game is *auction pinochle.* s played by three people, often with a fourth acting as dealer. The object of the game is to bid a certain num ber and then to reach that score. Players make points two ways. The winner of the bid *melds*—that is, the bi der lays down certain combinations of cards and sco the points they represent. After the hand has been played, the bidder also receives specified points for t cards in the tricks he or she has taken.

To begin play, the dealer gives 15 cards to each pla r and deals the remaining three, called the *widow,* face down. The player to the dealer's left bids first. The mi mum bid is usually set at 250. Every overbid must be multiple of 10, such as 260, 270, or 280. The player wh bids highest turns up the widow for the other players see and adds those cards to his or her hand. The bidd then names the trump suit and melds. The bidder ne discards three cards.

The bidder's opponents play as partners. The bidde picks up the meld cards and leads a card to start the fi trick. The other two players each play a card in turn, f lowing suit. A player who cannot follow suit must pla trump card. Each player, if able, must play a higher ra ing card than any cards previously played on the trick Each trick of three cards is taken by the person who plays the highest card in the suit led, or who trumps highest. If the two highest cards are alike, the one played first wins the trick.

A winning bidder collects a certain number of poin or chips from each opponent. The number, which va s according to local custom, is based on the size of the bid. A losing bidder pays each opponent twice this amount, or just once this amount if the bidder conce s defeat before playing out the hand. When spades are trumps, all points or chips gained and lost are double Double deck pinochle, with four players divided into partners, is another popular form. It uses two pinoch decks from which the nines have been removed. A si pler form of pinochle, with no bidding, is a popular t player game. R. Wayne Schmittberger

Piñon, *PIHN yuhn* or *PEEN yohn,* also spelled pinyo s the name of several species of small pines native to t Southwestern United States and Mexico. Piñons som times grow as sprawling shrubs, but they more ofter occur as small trees that measure 15 to 30 feet (5 to 9 meters) tall. Dry, open woodlands of piñons and junipers cover large areas of land that is too dry to support forests but not dry enough to be a true desert.

Piñons have short needles that grow singly or in cl ters. Piñon cones contain seeds, or *pine nuts,* with a d cate nutty flavor. Pine nuts form part of the traditional diet of Indians from the Southwest. Douglas G. Sprug

Scientific classification. Piñons belong to the pine family Pinaceae. The most common species are *Pinus monophylla,* *cembroides,* and *P. edulis.*

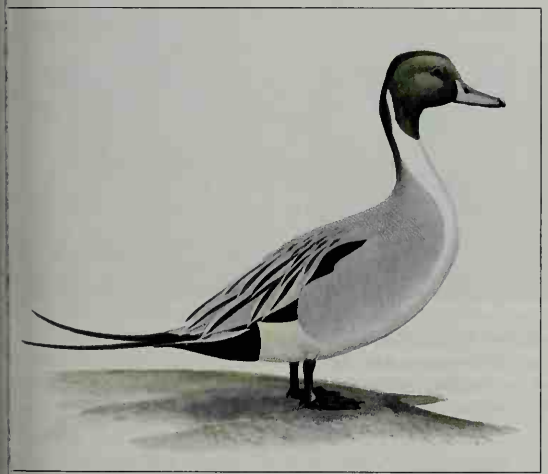
See also **Conifer; New Mexico** (picture: State tree); **Nevada** (picture: State tree).

'inscher. See **Doberman pinscher; Miniature pin-cher.**

'int is a unit of capacity in the inch-pound system of)easurement customarily used in the United States.)ne liquid pint equals 0.473 liter and one dry pint quals 0.551 liter. The *imperial pint* is sometimes used in ıe United Kingdom. But it has largely been replaced by ıetric units of measurement. One imperial pint equals .568 liter.

'inta. See **Caravel; Columbus, Christopher** (First voy-ge westward).

'intail is a freshwater duck with a long tail. It is found ıroughout the Northern Hemisphere and ranges over ıore of the earth than any other kind of waterfowl. In orth America, many pintails nest in Alaska and the ukon Territory. Some fly to eastern Siberia in Asia to est and then return to North America for the winter.



WORLD BOOK illustration by Trevor Boyer, Linden Artists Ltd.

ıe pintail is named for the long, pointed middle feathers of its l. The male pintail, *above,* is gray with a black tail.

A pintail has a brown head and neck, with a white line ı each side of the neck. The male is gray with a white east and black tail. Each wing has a patch of shiny een feathers along its edge. The female is brown and s a bronze patch on each wing. Pintails have blue-gray ls. Males have a black line on top of the bill. Pintails ː important game birds.

Scientific classification. The pintail belongs to the family atidae. Its scientific name is *Anas acuta.* Eric G. Bolen

nter, Harold (1930-), is an English playwright. ; dramas emphasize a sense of unspoken and some-ıes unexplained tensions between the characters.

Pinter's early plays are often called "comedies of men-ː" because they show ordinary people threatened or ıcked by mysterious forces. In *The Birthday Party* 58), two sinister men hunt down a meek man living in oarding house and punish him for some unspecified ense. In *A Slight Ache* (1959), a silent but menacing ·elict frightens a wealthy man into a mental collapse. ıer early plays include *The Dumb Waiter* (1957), *The llection* (1962), and *The Lover* (1963).

n the 1960's, Pinter explored the ways in which rela-ıships often break down into power struggles. In *The Caretaker* (1960), two brothers and a tramp form constantly changing alliances against each other. In *The Homecoming* (1965), a son's visit with his wife to his family home leads to a rearrangement of the family power structure. In later plays, Pinter examined how conflicting memories of the past make it impossible to be sure of what really happened. These plays include *Old Times* (1971), *No Man's Land* (1975), and *Betrayal* (1978). In the 1980's, he turned to political subjects, attacking the repressive methods of totalitarian governments in such plays as *One for the Road* (1984) and *Mountain Language* (1988).

Pinter has written many screenplays. He is also a stage director and has acted occasionally. Pinter was born in London. Gerald M. Berkowitz

Pinto. See **Horse** (Coat and skin; picture).

Pinworm, also called *threadworm,* is a small roundworm. Pinworms are *parasites.* That is, they live in the body of other animals. They are about $\frac{3}{8}$ inch (9 millimeters) long and have white bodies and pointed tails. Some pinworms infect horses and rabbits. One type, *Enterobius vermicularis,* commonly infects humans.

The young worms live in the upper part of the large intestine. When the females are ready to lay eggs, they crawl down the rectum and out the intestinal opening called the *anus,* usually at night. They lay eggs on the surrounding skin. This movement causes skin swellings and severe itching. The eggs fall off onto the bedding or clothing, or may be picked up under fingernails in scratching. If the eggs are swallowed, they reach the intestine and become adult pinworms.

Pinworms are not very harmful unless they are present in large numbers. But their eggs may infect other people or reinfect the original carrier. In some areas, 10 to 60 per cent of the children may have pinworms at some time. Doctors use drugs to treat infection caused by pinworms.

Scientific classification. Pinworms belong to the family Oxyuridae and the phylum Nematoda. David F. Oetinger

See also **Roundworm.**

Pion. See **Meson.**

Pioneer Clubs is an organization for girls and boys from preschool age to 17 years old. It conducts an interdenominational club program that teaches Christian principles and encourages personal growth through individual and group experience. The program centers around the motto *Christ in Every Phase of Life* and includes cultural, religious, and recreational activities.

Local clubs meet in churches and in about 25 camps throughout the United States and Canada. More than 100,000 girls and boys from about 2,500 churches of 80 denominations belong to the organization in those two countries. Clubs also operate in about 30 other nations. Every local club consists of five age divisions, each of which has a program for its age group. The Pioneer Clubs depend on adult volunteers for leaders, and the organization provides training sessions and educational materials for these leaders. This training information is available to youth leaders outside of the Pioneer Clubs.

The organization was founded in 1939 as Pioneer Girls. In 1981, it expanded its membership to include boys and the name was changed to Pioneer Clubs. Headquarters are at 27W 130 St. Charles Road, Wheaton, IL 60188. Critically reviewed by Pioneer Clubs



Approaching Chimney Rock (1930), a water color painting by William Henry Jackson; Scotts Bluff National Monument, Nebr

The pioneers pushed the frontier of the United States westward from the Appalachian Mountains to the Pacific Ocean. Most pioneer families traveled with several others who were making the same journey. West of the Mississippi River, many settlers who were headed for the Oregon region or California joined together to form caravans called *wagon trains, above.*

Pioneer life in America

Pioneer life in America. The story of the pioneers tells of the lives of thousands of ordinary people who pushed the frontier of the United States westward from the Appalachian Mountains to the Pacific Ocean. It is the tale of the many hardships and dangers and the isolation the settlers faced as they struggled to build new lives away from the civilization they had known in the East. It is also the story of a clash of peoples, as the pioneers sought to acquire lands where American Indians lived.

The pioneers played an important role in the history of the United States. They contributed much to America's knowledge about the geography, travel routes, and commercial possibilities of the West. They spread the political and social institutions and values of the new and growing nation across the continent. They also changed the look of the land as they cleared it for farms, roads, and towns. In addition, the pioneer settlement of America led to the loss of lands and traditional ways of life for many American Indians.

From about 1760 to about 1850, the pioneers moved westward in two large migrations. During the first migration, pioneers from the East Coast and from Europe advanced as far west as the Mississippi Valley. During the second migration, which began in the 1840's, settle from the East and Midwest migrated to the Oregon region and California. This article tells who the pioneers were, why they moved westward, and what their lives were like on the frontier. For the story of the first colonists, see **Colonial life in America.** For the history of s tlements in the West after 1850, see **Western frontier life in America.** See also **Westward movement in America.**

Jerome O. Steffen, the contributor of this article, is Professor of History at the University of Oklahoma.

Why the pioneers headed west

Pioneers moved west for a variety of reasons. Some went to the frontier in search of adventure. However, most pioneers headed west to make a better life for themselves and their children. They wanted to improv their social and economic position. Some hoped to ha more say in political affairs. Many young couples and single men sought their fortune on the frontier. Land was the chief form of wealth at the time, but it genera passed from father to oldest son. Even for those who had the money to buy land, good farmland was hard t

ind in the East. Across the Appalachians, however, settlers could obtain a plot of fertile land for a fraction of he cost of a similar piece in the East. In time, they might lecide to increase the size of their farms or sell them for profit.

The early settlers who crossed the Appalachian Aountains included people who were from Europe or vere of English, German, or Scandinavian descent. ome brought African-American slaves with them to the rontier. However, a number of pioneers were free black mericans who saw on the frontier a chance to start a ew life. Some of these African Americans had been reeased from slavery by their masters or by state legislaures. Others had bought their freedom or had run way. Many African Americans headed for the Northvest Territory, where slavery was illegal. The Northwest erritory, originally known as the Old Northwest, covred the area that is now Ohio, Indiana, Illinois, Michian, Wisconsin, and part of Minnesota.

However, some communities and territories passed ws that discriminated against African-American seters. For example, the Indiana Territory passed a law in 803 that prohibited blacks from testifying in any trial inolving whites.

Moving westward

Thousands of settlers crossed the Appalachian Mounins during the late 1700's and the early 1800's. These ioneers established frontier settlements in Kentucky, ennessee, Ohio, Indiana, Illinois, and other lands as far est as the Mississippi Valley. This section and the secons *A pioneer settlement* and *Pioneers and Indians* disiss this frontier. For the story of America's second big igration, to Oregon and California, see the section *rossing the Plains.*

Before the arrival of the pioneers. When the pioeers arrived in the region between the Appalachians id the Mississippi, they came upon a land of great natal beauty. Making up part of an area commonly called e Eastern Woodlands, the region had thick forests, arkling lakes and streams, and plentiful fish and game. ear the Mississippi River, the forest gave way to rolling prairie. The rich soil and adequate rainfall of the region made it well suited for farming.

The land between the Appalachians and the Mississippi River had been home to a number of American Indian cultures long before the pioneers arrived. The ancestors of some of these groups had come to the area as early as 10,000 B.C. The members of the powerful Iroquois League as well as such tribes as the Fox, Illinois, Sauk, and Shawnee inhabited the northern part of the region. The Cherokee and Chickasaw were among the tribes who lived farther south. The Indians of the Eastern Woodlands and nearby areas were farmers and hunters. They built permanent houses made of poles, bark, and mud. Many Native Americans lived in communities of several hundred people.

Stages of settlement. People of European descent came to the region between the Appalachians and the Mississippi River in several—often overlapping—stages. The first to visit the region were missionaries, fur traders, and explorers from England, France, and Spain. Soon, military outposts were established in the area. Later, American traders, explorers, and troops came to the frontier. They were followed by cattle ranchers, who grazed their cattle on the open prairies of the region. Finally, the pioneer farmers arrived on the frontier.

The first pioneer farmers made clearings for small farms. After several years, many of these settlers sought new opportunities on cheaper lands farther west. Their places were taken by pioneers who developed larger farms and built permanent communities. Soon the growing settlements attracted blacksmiths and other craftworkers, merchants, millers, doctors, and teachers.

Crossing the Appalachians. The first pioneers crossed the Appalachian Mountains along steep, narrow trails originally opened by Indians and later used by white explorers and traders. In time, the trails became wide enough for wagons. Boats carried pioneers on the rivers.

The pioneers followed several main routes on their way west. One route went through Cumberland Gap, a natural pass in the Appalachian Mountains near the meeting point of Kentucky, Tennessee, and Virginia. In

Colored wood engraving (1867) by an unknown artist; Granger Collection



A family camps on the trail, *left.* The pioneers could travel only a short distance each day. Most trips across the Appalachian Mountains took several weeks. In the West, the journey from Independence, Mo., to the Oregon or California region lasted four to six months.



Trails of the pioneers during the two big westward migrations are shown on the map above. The eastern region was settled by the pioneers during the first migration, in the late 1700's and early 1800's. The second migration, in the western region, began in the 1840's. The state boundaries on the map are shown as they exist today.

1775, a band of woodsmen led by Daniel Boone cut the Wilderness Road through the gap. Another route followed river valleys through Pennsylvania to Pittsburgh. There, many pioneers boarded river craft and floated down the Ohio.

In 1811, work began on a road that would eventually run between Cumberland, Md., and Vandalia, Ill. It became known as the National Road or the Cumberland Road. Many pioneers from New England traveled west on the Mohawk Trail across New York. Then they followed the southern shores of the Great Lakes. The Erie Canal became an important water route after its completion in 1825.

How the pioneers traveled. Most pioneer families joined several others who were making the same journey west. Some pioneers set off on foot, carrying only a rifle, ax, and a few supplies. However, most pioneer families had one or two pack animals and a wagon or a cart. Some took along a cow to provide milk and to carry a load of goods. Some had chickens, hogs, and sheep. Dogs herded sheep and helped hunt game.

The settlers could not take all their belongings with them when they traveled to the frontier. The two items that were essential for survival were a rifle and an ax. The rifle was needed for shooting game and for protec tion. The ax was used to cut logs for a raft or a shelter to clear land for a farm.

Any bulky tool or household utensil that could be made on the frontier was left behind. Most pioneers took along a knife, an axlike tool known as an *adz,* a to called an *auger* for boring holes, a hammer, a saw, a hoe, and a plowshare. Household goods consisted of a few pots and pans, an iron kettle, and perhaps a spinning wheel. Families made room for essential clothing blankets, and such prized possessions as a clock and family Bible. They also brought along seed for planting their first crops on the frontier.

The pioneers hunted and fished for food on their journey. They also carried some corn meal, salt pork, and dried beef. *Johnnycake,* a kind of corn bread, was favorite food because it did not spoil on the long trip.

The pioneers could travel only a short distance each day, and most trips across the mountains took several weeks. Later, after roads had been built, the *Conestog*





Oil painting on linen (between 1869 and 1890) by Carl Christensen; Private collection (Granger Collection)

Temporary shelters made of a framework of poles covered with branches and mud housed pioneers when they first arrived at a settlement, *left.* Settlers built permanent dwellings when they had more time to spare after planting their first crops.

agon became the favorite vehicle for travel. Conesto-
is had broad-rimmed wheels, sloping sides that were
gher than the middle, and a rounded, white canvas
of. They were pulled by horses, oxen, or mules. The
onestoga was named for the Pennsylvania valley where
was first built. See **Conestoga wagon.**

A barge known as a *flatboat* was commonly used for
er traffic. Early flatboats could carry one family, a
agon, and several horses or other livestock. Later flat-
oats were large enough to transport several families
th all their supplies and livestock. These boats had a
oxlike house in their center. The house became a float-
g fort in case of attack by Indians or river pirates.
me of the pioneers ended their journey by settling
ar the river. They took apart the house and flatboat
d used the lumber to build shelters ashore. Other
es of river craft included simple rafts; canoes; narrow
rges called *keelboats;* and, after 1811, steamboats.

How the pioneers obtained land depended on
here and when they settled. During the early settle-
ent of Kentucky and Tennessee, for example, pioneers
nply located and staked out the lands they wanted.
on land companies and wealthy individuals called
d speculators began to claim huge pieces of land.
ese groups and individuals bought land or received
nership from colonial governments or by royal de-
e. They divided the land into smaller homesites and
n resold it to the settlers for a profit.

Land speculators sometimes acquired land from the
lians in the region. In many cases, however, the Indi-
s believed they were granting only the right to use the
d, not the right to possess it. Furthermore, Indian
ds belonged to the tribe as a whole. A group of indi-
uals, even if they were chiefs, did not have the right
sell the lands. These misunderstandings were among
causes of conflict between whites and Indians.

law called the Ordinance of 1785 provided for the
ision and sale of land north of the Ohio River be-
en the Appalachian Mountains and the Mississippi
River. It stated that land there could not be settled until after the federal government had surveyed it. After the land was surveyed, it was to be sold at government auction to the highest bidder. Speculators and land companies bought most of the land and resold it in smaller plots to settlers.

Many pioneers settled on public land before it had been surveyed. These settlers, who did not have title to the land, were known as *squatters.* In 1841, Congress passed a law that enabled squatters to buy their land under rights of ownership called *squatter's rights.*

Establishing a homestead. When a pioneer family arrived where they intended to settle, they could not spare enough time to build a permanent house right away. Instead, they put up a temporary shelter. A framework of poles covered with branches and mud formed the roof and three sides of the shelter. The fourth side was open and faced a fire that burned day and night. During the day, the fire was used to cook food. At night, it warmed the shelter and kept away wild animals.

Most pioneers arrived at a settlement in spring, the planting season. A spring arrival gave them time to clear the land and grow crops for the next winter. Pioneers used axes to cut away the brush, chop down trees, and trim logs. Neighbors lent a hand removing rocks and stumps. Every member of the family helped with the work of starting life on the frontier.

A pioneer settlement

The log cabin was the typical pioneer home in Kentucky, Tennessee, and many other wooded regions. The pioneers cut trees into logs and then chopped notches close to the ends. The notches held the logs to each other when they were fitted together to form the sides of the cabin.

Most log cabins were about 16 feet (4.9 meters) wide and 20 feet (6 meters) long. The sides of a cabin were about 7 feet (2.1 meters) high. The logs were too heavy for one person to lift, and so neighbors gathered to help



The log cabin was the typical pioneer home in regions where wood was plentiful. The settlers cut trees into lo that were fitted together to form the sides of the cabin. The roof consisted of logs covered by *clapboards* (thin boards). The cabin shown at the left does not yet have a complete roof.

Detail of a lithograph by Currier and Ives; Bettmann Archive

one another. The job was called a *house-raising.* After the logs were in place, the spaces between them were plugged with moss, clay, or mud. Filling the spaces was called *chinking.*

Roofing began after the cabin walls had been completed. First the pioneers fitted logs together on top of the walls to form the frame of the roof. Then they fastened *clapboards* (thin boards) to the frame. They overlapped the clapboards so that rain would run off. Few of the early pioneers had building nails. They used wooden pins to hold the parts of the roof together.

The ground served as the cabin floor until the family found time to make a wooden floor. Pioneers split logs lengthwise into long slabs called *puncheons.* Then the pushed them into the earth, split side up, and wedged them together. A puncheon floor was smoother and warmer than the ground, and it improved the looks of the cabin.

A fireplace stood at one end of the cabin. Most fireplaces had a log chimney that was lined with a thick layer of clay or mud to keep it from catching fire. Some had stone chimneys. The family kept a fire burning in the fireplace most of the time for cooking and to provide warmth and some light.

Conner Prairie



Preparing a family meal sometimes included peelin and cutting up apples for a tasty apple pie, *left.* This pho tograph and the ones on the following pages were taken historic villages that re-crea pioneer life.

Some frontier cabins had no windows, and others ıd only small ones. Pioneers covered windows with ıutters or with greased paper, which let in light. Glass ter replaced these window coverings when shopkeep- s brought it from the East.

The cabin door was made of thick pieces of wood fas- ned to crosspieces. The door swung on wooden nges. A deerskin string was tied to the latch and hung ıtside. When someone pulled the latchstring, it drew) the latch and the door opened. At night, the latch- ring hung inside, and the family put strong bars across e door to hold it shut.

Furniture and household utensils. A family started e on the frontier with a few pieces of handmade furni- re and some household utensils. After getting settled, e pioneers bought other items from a peddler or a ɔntier store. Every growing settlement had a black- nith, a cabinetmaker, and other craftworkers.

The family's table was made of several split log slabs ıd sturdy legs. Benches and stools were made of naller slabs. A pole stuck into a wall formed the out- de rail of the bedstead. A notched post held up the ɘe end of the pole. Cross poles laid from the pole to a de wall held a mattress stuffed with dried moss, grass, straw. Quilts, blankets, or animal skins served as bed- ıvers. Many pioneers had no beds. They rolled up in ɘar or buffalo skins and slept on the floor. Some cabins ıd a loft where the children slept.

Pioneers made many of their household utensils. They rved wooden spoons, ladles, bowls, and platters. They so whittled long pegs that were driven into cabin walls hold the family's clothing. Deer antlers, hung over the ɔor or fireplace, made a good rack for the pioneer's le, bullet pouch, and powder horn. Gourds served as ıps and containers. Candles provided light.

Food. Corn and meat were the basic foods of a pio- ɘer family. The family ate corn in some form at almost ery meal. The pioneers grew corn as their chief crop r several reasons. It thrived even in uncultivated soil, pt well in any season, and could be used in many



Conner Prairie

A blacksmith was an important member of many pioneer communities. Blacksmiths shaped tools and other iron products in their workshops and then sold these goods to the settlers.

ways. The pioneers ground corn into meal. They used the meal to make mush or various kinds of corn bread—ashcake, hoecake, johnnycake, or corn pone. They also made a dish called *hominy* by softening whole, dried corn in lye or water to remove the hull. For a special treat, families roasted ears of corn. The pioneers also used corn as feed for their animals.

The pioneers raised cattle, hogs, sheep, and chickens. They also hunted wild fowl and other game for much of their meat supply. Many meals consisted of wild duck, pigeon, or turkey, or bear, buffalo, deer, opossum, rabbit, or squirrel. Fish were abundant in lakes and streams.

The pioneers had no refrigeration, but they knew how to keep meat from spoiling. They cut some kinds of meat into strips that they dried in the sun or smoked over a fire. Some meat, especially pork, kept well after being salted or soaked in *brine* (salty water).

Salt was in great demand on the frontier for preserving and seasoning food. It brought a high price when traders from the East sold it by the barrel. Rather than

Conner Prairie



A cabinetmaker provided settlers with finely crafted furniture and other wooden products. Before a cabinetmaker arrived at a settlement, pioneers made their own furniture and such household utensils as wooden spoons and bowls.



Living History Farms

Cornhusking was one of the first steps involved in preparing corn meal. Pioneer families used the ground meal to make mush and various kinds of corn bread. Corn was a basic food of the pioneers, and they ate it in some form at almost every meal.



Living History Farms

Chopping wood for a fire required a strong hand and a sturdy ax. An ax and a rifle were the two items that pioneers considered essential for survival on the frontier.



Conner Prairie

Carrying fresh water from a well, stream, or other source was backbreaking labor. Members of a pioneer family shared the tasks that needed to be done around a homestead.

pay the high price, some settlers banded together once a year and traveled to a *salt lick.* Salt formed naturally on the ground at some salt licks. Salt springs bubbled up out of the ground at others. At a salt lick, settlers could gather salt or boil their meat in the salty water. Wild animals also came to licks for the salt, and so pioneers often found good hunting there.

The pioneers grew vegetables and herbs for their own use and occasionally to trade with a local shopkeeper for other goods. Most of the vegetables planted by the settlers—beans, cabbages, potatoes, pumpkins, squash, and turnips—could be cooked into hearty meals. Herbs used by the pioneers included garlic, parsley, rosemary, sage, and thyme.

Families that owned a cow often had milk with their meals. Coffee and tea were too expensive for most frontier families except on rare occasions. Whiskey made from corn was a common drink. The pioneers sometimes mixed corn whiskey with water, added some sweetener, and served it to the entire family. Common sweeteners included honey, molasses, and maple sugar or maple syrup.

Clothing. For their first year or two on the frontier, most pioneers wore the clothes they had brought with them. After this clothing wore out, they made their own. Fabrics were expensive, and making clothes was a long and difficult process. Pioneer women generally took responsibility for making clothes. They spun linen yarn from flax and wool yarn from the fleece of sheep. They then wove the yarn into cloth, which they used in making shirts, trousers, dresses, and shawls.

Many frontiersmen wore a hunting shirt made of deerskin or *linsey-woolsey,* a coarse homemade cloth of linen and wool. The shirt fitted loosely and hung to the thighs. It had no buttons and was held in place at the waist by a belt. Instead of a collar, the shirt had a cape, sometimes trimmed with fringe. Frontiersmen wore deerskin trousers. Deerskin became cold and stiff when wet and felt uncomfortable next to the skin. A man in deerskin usually wore underclothes of linsey-woolsey.

Linsey-woolsey was also commonly used to make



Conner Prairie

laking clothes was generally the responsibility of pioneer 'omen. They spun yarn and then wove it into cloth, *above.* They ›ed the cloth to make shirts, trousers, dresses, and shawls.

othing for women and children. Most pioneer women 'ore a petticoat and a dress that resembled a smock. 'he petticoat was worn as a skirt, rather than as an un-ergarment. In cold weather, women wore a shawl of 'ool or linsey-woolsey. Children wore the same kind of lothing as their parents.

The pioneers wore the shoes that they had brought 'ith them for as long as they could. They went barefoot 'henever possible to extend the life of their shoes. Vhen their shoes finally wore out, the pioneers bought ew ones from a local merchant or bartered furs or ther goods for shoes. In the early stages of frontier life, ɔme settlers made moccasins or *shoepacks* of hide. hoepacks resembled moccasins, but they covered the nkles and had sturdy soles. For warmth and comfort, ıe pioneers stuffed their moccasins or shoepacks with eer hair or leaves.

In summer, the women and girls wore sunbonnets rge enough to shield the face and neck. In winter, they 'ore woolen bonnets or covered their heads with ıawls. Men and boys wore coonskin caps or fur hats in ɔld weather. In summer, they put on hats made of ›osely woven straw or cornhusks.

Tools. Pioneers started farming with the hoe, plowshare, and other tools that they brought with them. The cabin soon became a workshop as well as a home. The pioneers made most of their own farm tools, including harrows and rakes, which were used to break plowed earth into finer pieces and smooth the soil.

A number of tools and techniques were involved in making corn meal. First, the pioneers pulled off the cornhusks. In most cases, they then *shelled* the corn—that is, they removed the kernels from the ear. Some pioneers separated the kernels from the cob by hand. Others used a homemade threshing tool called a *flail* or another implement.

The pioneers made several kinds of mills to grind the kernels into meal. Some made a hand mill called a *quern.* This mill consisted of two large, flat stones, one on top of the other. The top stone had a wooden handle attached to it and a hole through the center. Kernels were placed in the hole. When the handle was turned, the corn was ground into meal between the stones. Another type of mill consisted of a heavy log and a hollowed tree stump. Corn was put into the hollow and pounded into meal with the log. Some pioneers simply grated the corn into a coarse meal. They made a grater by punching holes in a sheet of iron and fastening it to a block of wood. A husked ear of corn was rubbed against the sharp, raised edges of the holes in the metal.

The pioneers usually molded their own bullets from lumps of lead sold by the settlement storekeeper, who also sold gunpowder. They obtained iron tools from a blacksmith. Pioneers often used corn or corn meal instead of money to buy supplies. If a settlement had no store, a few settlers traveled together to the nearest town or trading post to buy what they needed.

Health. One of the greatest dangers to the pioneers was disease. Epidemics on the frontier killed large numbers of people, especially children and older people. The most feared disease was smallpox. Many communities suffered outbreaks of cholera, malaria, and yellow fever. Such childhood diseases as whooping cough, diphtheria, and scarlet fever were common.

The settlers also suffered from colds and other minor illnesses. Nearly everyone was affected at one time or another by a malarial fever called *ague.* Accidents resulting in cuts, bruises, sprains, and broken bones occurred frequently. Childbirth was dangerous. Pioneer women bore children without the benefit of proper medical care. Many women died in childbirth, and many children died at birth or as babies.

There were few doctors on the frontier. The main responsibility for caring for the sick fell upon the pioneer women. They relied on a combination of home remedies and folk cures to treat illnesses. For example, one cure for colds and sore throats involved tying a piece of fat meat with pepper around the neck of the sufferer. Wearing a bag of *asafetida,* an herb that smells like garlic, around the neck was said to keep a person healthy. Some diseases were treated by *bloodletting*—that is, having some blood removed from patients. Bloodletting, also called *bleeding,* was believed to remove "bad blood" and fever from the sick. This procedure was typically carried out by a doctor, *apothecary* (pharmacist), or barber.

Indian cures were also popular among the pioneers.



Bettmann Archive

A settlement school had few books and no chalkboards, charts, or maps. The children sat at long wooden benches or crude desks and repeated lessons given by the teacher. Most teachers had little, if any, formal training.

Such treatments often involved the use of plants, herbs, and the bark of trees. For instance, a brew of boneset tea was used to treat colds. Chewing prickly-ash bark eased toothaches. Sassafras and goldenseal helped relieve stomach ailments.

Education. At first, education on the frontier was informal. Parents who could read taught children some lessons from the Bible and other books that they brought with them from the East. Soon, frontier communities set up formal schools. Most schools had only one room and were built by the settlers. The pupils sat at long wooden benches or crude desks.

Teachers were scarce. Many did not stay long in a particular area, and others left the profession after only a few years. In many cases, a teacher was *boarded around* in payment for services. The teacher lived for a few months with one family and then with another, receiving food and lodging. Some communities paid their teacher a small salary. Most teachers had little, if any, formal training.

A settlement school had few books and no chalkboards, charts, or maps. The children learned by repeating lessons read by the teacher. The teacher taught them reading, writing, and arithmetic. Famous textbooks included the readers of William H. McGuffey and the spelling books of Noah Webster. Spelling bees were both a part of the school curriculum and a popular form of recreation. Adults and children alike competed for the honor of being the best speller in the community.

Students wrote on wooden boards and used pieces of charcoal as pencils. Some had pens made of goose quills and ink made from bark or berries. Slates came into use about 1820. Most children attended school only during the winter. At other times, they were needed at home to help with the farm and household tasks.

Religion was an important part of pioneer life. Most settlers were Christians, and almost every large pioneer settlement had a church. In small settlements, services were held in family homes. Parents taught prayers and hymns to their children and tried to keep Sunday as a day of rest and worship.

A traveling preacher visited many settlements regularly. He conducted church services and funerals and performed marriages and baptisms. The preacher was called a *circuit rider* because he rode horseback from one settlement to another on a route known as a *circuit.*

Sometimes a preacher organized a *camp meeting.* This special outdoor religious service lasted several days and nights and attracted families from many settlements. People brought food and other supplies and camped in a large clearing where the meeting was held. Members of many religious groups attended camp meetings, which often featured several preachers. Methodists typically made up the largest group, but such denominations as Baptists and Presbyterians also took part.

Camp meetings and other religious gatherings served an important social function in addition to a religious role. They were good places to catch up on news or simply gossip. They also enabled single men and women to make friendships that could lead to courtship and marriage.

Government. Early frontier settlements had no formal governmental bodies or law enforcement officials. The community as a whole usually made decisions, settled disputes, and punished troublemakers. Sometimes a special commission consisting of several prominent members of the community was set up to resolve conflicts between individuals.

In 1787, Congress passed the Northwest Ordinance. This law established rules for formal government in the Old Northwest, which then became known as the Northwest Territory. This territory became a model for all territories that later entered the Union as states. The ordinance declared that at first a territorial government would consist of a governor, a secretary, and three judges appointed by Congress. After its adult male population reached 5,000, a territory could elect a legislature and send a nonvoting delegate to Congress. After the population reached 60,000, a territory could write a state constitution and apply for statehood.

Generally, the first action a territorial government took was to organize a local militia. The militia served as

territory's military force. It also supervised elections nd set and collected taxes. In time, officials of the ounty court system took over many functions from the nilitia. These officials included a surveyor, a treasurer, a oroner, a sheriff, a justice of the peace, and a county lerk. They kept law and order, issued licenses, and set ees for local businesses. They also assessed and colected taxes.

Social activities. The pioneers brightened life on the rontier with parties and other get-togethers. They nixed work with fun and sports whenever possible. In iutumn, they held cornhusking contests and nutjathering parties. In spring, they assembled in maple jroves to make sugar and syrup. The women often got ogether for quilting parties. The quilts were much in lemand as bedcovers.

The settlers always enjoyed a house-raising. The men stopped working on the house now and then to run aces or to hold wrestling bouts or shooting contests. After the job was finished, everyone celebrated with a ively feast. The women prepared plenty of food, and after eating, the settlers sat around telling stories. As a ule, someone brought along a fiddle, and dancing and singing went on until late in the night.

A wedding was a special time of fun and celebration. The pioneers liked to play tricks on a couple about to be married. Sometimes the women "kidnapped" the bride while the men rode off with the groom. Of course, both managed to escape in time to be married. During the couple's wedding night, some guests, usually young men and boys, gathered outside the newlyweds' home. There, the assembled group shouted, banged on pans, and otherwise created great noise in a tradition called a *charivari* (pronounced *SHIHV uh REE).*

Pioneers and Indians

Peace and war. During the colonial period, the British Proclamation of 1763 forbade white settlement west of an imaginary line drawn through the Appalachian Mountains. The proclamation was designed to prevent pioneers from moving onto Indian lands, which the Indians were prepared to defend. But many colonists ignored the proclamation, which was not strictly enforced, and settled west of the Appalachians anyway. Treaties negotiated with the Indians in 1768 shifted the proclamation line westward and opened the way for settlement of what are now West Virginia and southwestern Pennsylvania. Some pioneers went as far west as what are now eastern Kentucky and Tennessee.

Beginning with President George Washington, the official policy of the United States toward Indians was generally one of peace through negotiation, trade, and treaties. According to laws passed during the 1790's, only the U.S. government could acquire land from the Native Americans. Trade between white traders and Indians was to be regulated by the government to curb unfair practices. Laws and treaties recognized and guaranteed Indian rights to certain lands.

However, neither the U.S. government nor the Native Americans foresaw the crush of settlers that would be moving west in the early 1800's. The pressure of white settlement was so great that orderly relations between the pioneers and the Indians were difficult to maintain. Many land speculators and settlers ignored the rights that Indians had been guaranteed under treaties. Some whites—including some militias—conducted armed invasions into lands that had been reserved for the Indians. Some Indians raided pioneer settlements.

There were several periods of major fighting between Indians and U.S. troops in the region between the Appalachians and the Mississippi River. A series of conflicts between the Army and the Indians north of the Ohio River, in the Northwest Territory, occurred during the early 1790's. It ended in an Indian defeat in the Battle of Fallen Timbers in 1794.

A second major period of hostility began in the early 1800's. At that time, a Shawnee leader named Tecumseh and his brother Tenskwatawa, known as the Shawnee Prophet, organized an alliance of Indian tribes to raid frontier communities. Tecumseh objected to the pioneer settlement of Indian lands. Many tribes in Tecumseh's alliance joined forces with the British against the United States during the War of 1812. Tecumseh was killed in Canada at the Battle of the Thames River in 1813. The Indian uprising ended shortly after his death. See **Indian wars.**

The early treaties between the United States and the Native Americans guaranteed that the Indians could remain on certain lands. However, as more settlers moved into the area between the Appalachians and the Mississippi River, the Indians were pushed off their land. In 1834, the U.S. government created the Indian Territory, a large Indian reservation west of the Mississippi. The reservation spread across an area that covers what are now Oklahoma and parts of Kansas and Nebraska. By 1840, more than 70,000 Indians from east of the Mississippi River had been forced to move to the Indian Territory. Thousands of Cherokee, Chickasaw, Choctaw, and other Indians died on the journey westward. The Cherokee came to refer to their migration as the Trail of Tears. The name was later applied to the forced removal of other tribes as well.

Defending a settlement. Most settlers were never attacked by Indians, but they lived in constant fear of Indians nevertheless. Everyone kept careful watch for Indians and warned their nearest neighbors at the first sign of danger. Messengers spread the alarm throughout the settlement.

A fort called a *stockade* or *station* was the main defense of a frontier settlement. A typical stockade was rectangular, with walls of sharply pointed logs at least 10 feet (3 meters) high. Small sheds or cabins provided living quarters in the stockade. In at least one of the corners of the fort stood a *blockhouse,* a two-story tower built of thick timber. Some stockades had a blockhouse in each corner. A blockhouse held at least 25 people. Members of the local militia stood guard at *firing posts* in blockhouses. Firing posts were narrow slits in a wall, just wide enough to shoot through.

The stockade also sheltered new arrivals at a settlement. Newcomers headed for the stockade, where they learned what to do in case of an alarm. Most new arrivals at an established settlement stayed in the stockade until they began settling on their land.

Crossing the Plains

By the 1830's, the first big westward migration had pushed the frontier to the Mississippi Valley. Pioneers



Detail of *The Oregon Trail* (1869), an oil painting on canvas by Albert Bierstadt; Butler Institute of American Art, Youngstown, Ohio

Oregon-bound pioneers encountered many types of terrain, including rugged mountains and a number of rivers, during their trip. From 1840 to 1860, more than 300,000 people made the long journey to the West.

were rapidly settling the area just west of the Mississippi River that became the states of Arkansas, Missouri, and Iowa. Explorers, missionaries, traders, and fur trappers had gone even farther west and southwest. They told of great forests and fertile valleys in the Oregon region and other lands west of the Rocky Mountains.

The stories of the trailblazers made exciting news for many Midwestern settlers. In the 1840's, some Midwesterners chose to migrate to Oregon in search of more opportunities. So did hundreds of families from the East who had just arrived in the Midwest and were seeking places to settle. The Mormons, fleeing persecution in Illinois because of their religious beliefs, also decided to head westward. In 1847, they began to settle in the valley of the Great Salt Lake in what is now Utah. Some Midwestern blacks hoped to escape discrimination by moving to the West, but they often faced prejudice there as well. After gold was discovered in California in 1848, thousands of fortune seekers joined the westward migration. See **Mormons; Gold rush.**

Routes to the West. The settlers encountered several natural obstacles on their way to the fertile valleys of Oregon or the gold fields of California. First, they had to cross the Great Plains, a vast grassland that runs between Canada in the north and Texas and New Mexico in the south. The rugged Rocky Mountains rose west of the Great Plains, and beyond the mountains lay a stretch of desertlike terrain known as the Great Basin. The weather was also a problem. Heavy rains might wash out a river crossing. A spell of dry weather could lead to a shortage of water to drink, less grass for the cattle to eat along the way, and more dust to choke the travelers.

From 1840 to 1860, more than 300,000 people crossed the plains and mountains of the West. Most were bound for Oregon or California. For the long trip, as many as 200 wagons at a time joined together to form a caravan called a *wagon train.* However, trains of 30 or fewer wagons were more common. Most settlers started from Independence, Mo., and followed a route called the Oregon Trail. Those bound for Oregon took this trail northwest to the Columbia River and from there to the Willamette Valley.

Settlers bound for California split off from the Oregon Trail near Fort Hall, in what is now Idaho. They followed any of several trails southwest to Sacramento, Calif. Some settlers took the Santa Fe Trail from Independence to California. This route took settlers to Santa Fe, in present-day New Mexico. From there, pioneers followed the Old Spanish Trail to Los Angeles.

From 1835 to 1855, more than 10,000 people died while traveling on the Oregon Trail. The chief causes of death were firearms accidents and such diseases as cholera and smallpox. Only 4 percent of the deaths among pioneers on the Oregon Trail resulted from Indian attacks.

The wagon train. A family going from Independence to Oregon or California in the 1840's had to plan on a journey of four to six months. They had to be sure they brought enough supplies for the trip because there were few places where they could buy goods along the way. Often travelers traded such items as food, clothing, and firearms among themselves or purchased them from one another. Several guidebooks provided information on the route the travelers were to take as well as tips on what provisions were needed for the journey.

During most of the trip, the family lived in a canvas-covered wagon pulled by several teams of oxen or mules. The wagon resembled the Conestoga but was smaller and sleeker. It was called a *prairie schooner* because, from a distance, its white top looked like the sails of a ship. Many families painted pictures and slogans on the wagon's canvas covering for decoration. Such markings also made it easier for friends to find each other on the crowded trail.

Some single men traveled on horseback with wagon trains. They herded the livestock or rode alongside the wagons, helping the drivers stay on the trail. A wagon train had a large number of livestock. Some trains included more than 2,000 cattle and up to 10,000 sheep.

Each wagon train elected a leader, called a captain or wagon master. All wagon trains were guided by a scout who knew the route and the best places to camp.

Life on the trail. Almost all westward journeys started in the spring. A spring departure gave the pio-

escriptions of the Western trail

The diaries kept by many pioneers of the 1840's tell mostly of hardships and tragedies on the trail westward. However, not all memories of the journey were sad. Octavius T. Howe, describing the migration of the 1840's, wrote:

> . . . those who crossed the plains, though they lived beyond the age allotted to man, never forgot the ungratified thirst, the intense heat and bitter cold, the craving hunger and utter physical exhaustion of the trail, and the rude crosses which marked the last resting places of loved companions. But there was another side. Neither would they ever forget the level prairie, covered with lush grass and dotted with larkspur, verbena, lupin, and geranium; the glorious sunrise in the mountains; the campfire of buffalo chips at night, the last pipe before bedtime and the pure, sweet air of the desert. True they had suffered, but the satisfaction of deeds accomplished and difficulties overcome more than compensated and made the overland passage a thing never to be forgotten and a lifelong pleasure in remembrance.

From *Argonauts of '49*, courtesy of Harvard University Press

The circle formed by pioneer wagons at night became a famous symbol of life on the trail. Probably the best description of such a circle was written by Jesse Applegate, one of the leaders of a wagon train bound for Oregon. In *A Day with the Cow Column in 1843,* he wrote:

> . . . the sun is now getting low in the west, and at length the painstaking pilot is standing ready to conduct the train in the circle which he has previously measured and marked out, which is to form the invariable fortification for the night. The leading wagons follow him so nearly round the circle, that but a wagon length separates them. Each wagon follows in its track, the rear closing on the front, until its tongue and ox chains will perfectly reach from one to the other, and so accurate the measurement and perfect the practice, that the hindmost wagon of the train always precisely closes the gateway. . . . Within ten minutes from the time the leading wagon halted, the barricade is formed, the teams unyoked and driven out to pasture . . .

The cost of heading for California

Several guidebooks provided information on the routes travelers were to take to the West as well as tips on what provisions were needed. The costs of a westward journey varied, depending on the final destination, whether the wagon was to be pulled by mule or oxen, and other factors. Many guidebooks, therefore, offered several estimates of the cost of a trip to the West. The table below gives an estimate for a one-year journey by three people to California in a wagon pulled by oxen. It is based on a table in *The Emigrant Guide to California* by Joseph Ware. This guidebook was published in 1849, one year after gold was discovered in California. The inclusion of mining tools in the list of provisions suggests this estimate was aimed at fortune seekers headed for the California gold fields.

Item	Quantity	Cost
Four yoke of oxen	at $50	$200.00
One wagon cover, etc.		$100.00
Three rifles	at $20	$60.00
Three pair pistols	at $15	$45.00
Five barrels flour	1,080 lbs.	$20.00
Bacon	600 lbs.	$30.00
Coffee	100 lbs.	$8.00
Tea	5 lbs.	$2.75
Sugar	150 lbs.	$7.00
Rice	75 lbs.	$3.75
Fruit, dried	50 lbs.	$3.00
Salt, pepper, etc.	50 lbs.	$3.00
Saleratus (baking soda)	10 lbs.	$1.00
Lead	30 lbs.	$1.20
Powder	25 lbs.	$5.50
Tools, etc.	25 lbs.	$7.50
Mining tools	36 lbs.	$12.00
Tent	30 lbs.	$5.00
Bedding	45 lbs.	$22.50
Cooking utensils	30 lbs.	$4.00
Lard	50 lbs.	$2.50
Private baggage	150 lbs.	
Matches		$1.00
One mule		$50.00
Candles and soap	50 lbs.	$5.30
Total	2,583 lbs.	$600.00

Cost to one person: $200

neers time to get through the western mountains before snow blocked the passes. It also helped ensure adequate grass for the livestock. Most wagon trains could travel about 12 to 20 miles (19 to 32 kilometers) a day. They stopped for a day or two at such Wyoming outposts as Fort Laramie or Fort Bridger to repair equipment and buy supplies. If the oxen hauling the wagons became exhausted, they were shot or simply left to die where they fell. Some were eaten for their meat. In most cases, they were replaced by other animals that had been herded behind the wagon train.

A day on the trail began shortly before dawn. After the travelers rounded up their livestock, hitched their teams to the wagons, and ate breakfast, the train started out. About midday, it stopped for a break known as *nooning.* This break gave both the pioneers and the livestock a chance to eat and to rest. Afterward, the train pressed on to the place where the travelers would camp for the night. When the train arrived at the campsite, the wagons formed a circle for protection against wild animals and possible Indian attacks. In the evening before bed, the pioneers gathered around campfires in the circle to eat and chat. Sometimes, if someone had a fiddle, they sang and danced. Usually, however, they were so exhausted by their day on the trail that they went to sleep as early as possible.

Indians on the Plains. The Oregon Trail crossed lands that the U.S. government had guaranteed to the Indians. The route ran through Indian hunting grounds. Fighting occasionally broke out between the pioneers and the Indians, who opposed this intrusion on their territory. However, most wagon trains had a peaceful journey along the trail. Some tribes guided the early pioneers or helped them at difficult river crossings. The Indians supplied some wagon trains with vegetables and buffalo meat in exchange for tobacco, whiskey, or pieces of iron. During the late 1850's and early 1860's, farmers and cattle ranchers began to settle on the Great

Plains. At that time, fighting became more common as tribes sought to defend their territory. Jerome O. Steffen

Related articles. For the history of pioneering in the various states, see the *History* section of state articles, such as Ohio (History). See also the following articles:

Biographies

Appleseed, Johnny
Boone, Daniel
Bowie, James
Bridger, Jim
Carson, Kit
Chouteau, Jean Pierre
Chouteau, René Auguste
Clark, George Rogers
Clark, William
Colter, John
Crockett, Davy
Dubuque, Julien
Fink, Mike
Frémont, John C.
Girty, Simon
Gist, Christopher
Goodyear, Miles
Jemison, Mary
Lewis, Meriwether
Marshall, James W.
McGuffey, William H.
McLoughlin, John
Rice, Henry M.
Sevier, John
Smith, Jedediah S.
Sublette, William L.
Webster, Noah
Whitman, Marcus

Pioneer travel

Bozeman Trail
Chisholm Trail
Conestoga wagon
El Camino Real
Erie Canal
Flatboat
Mohawk Trail
Natchez Trace
National Road
Oregon Trail
Santa Fe Trail
Wilderness Road

Other related articles

Blockhouse
Boom town
Camp meeting
Circuit rider
Colonial life in America
Forty-Niners
Franklin, State of
Gold rush
Indian, American
Indian Territory
Indian wars
Log cabin
Northwest Ordinance
Northwest Territory
Scout
Squatter's rights
Trading post
United States, History of the (Expansion)
Watauga Association
Western frontier life in America
Westward movement in America

Outline

I. Why the pioneers headed west
II. Moving westward
A. Before the arrival of the pioneers
B. Stages of settlement
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D. How the pioneers traveled
E. How the pioneers obtained land
F. Establishing a homestead
III. A pioneer settlement
A. The log cabin
B. Furniture and household utensils
C. Food
D. Clothing
E. Tools
F. Health
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IV. Pioneers and Indians
A. Peace and war
B. Defending a settlement
V. Crossing the Plains
A. Routes to the West
B. The wagon train
C. Life on the trail
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Questions

What was the Northwest Territory? The Indian Territory?
What two items were necessary for survival on the frontier?
What were two main routes followed by the early pioneers across the Appalachian Mountains?
Why was corn the chief crop of the pioneer farmer?
What was the Trail of Tears?
Who were the first white people to visit the region between the Appalachians and the Mississippi?
What was a *circuit rider?* A *camp meeting?*
What were the chief causes of death along the Oregon Trail?
Why did pioneer children attend school only during the winter?
What was the main defense of a pioneer settlement?

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Pipe is probably the oldest of musical instruments. Pipes are the ancestors of the present pipe organ and all other wind instruments. According to Greek mythology the god Pan invented pipes (see **Pan**). Prehistoric people fashioned bones into primitive pipes.

The flute is a pipe of the *whistle* type. In this musical instrument, air blown against a sharp edge sets in motion the air in a hollow tube. The oboe and clarinet are *reed pipes.* In these musical instruments, the movements of a thin piece of wood or other material set the air in motion. The trumpet operates on the principle of setting the air in motion through vibrations of the player's lips. André P. Larson

See also **Organ; Clarinet; Flute; Trumpet.**

Pipe is a tube used to transport liquids and gases from one place to another. Pipelines compare in importance with highways and railroads as a means of transporting materials useful to people. Huge pipes bring water to the city from wells, lakes, or other sources of supply. A vast network of pipes then distributes the water to homes, and to each sink, toilet, and other water fixtures in the house. Another network of pipes carries the wastewater away from these fixtures through drains and sewer pipes (see **Sewage**). Long pipelines buried in the ground transport and distribute natural gas in the United States and Canada in the same way water is distributed (see **Pipeline**). Similar pipelines transport crude oil from wells to refineries.

The walls, floors, and basements of modern office buildings and hotels have a maze of pipes. The pipes

arry hot and cold water for general use, steam for heat-ng, and refrigerants for air conditioning. Chemical fac-ries, refineries, and similar industries depend almost ntirely on pipes to move their products about within e manufacturing plant. Warships often have such a aze of pipes that sailors on the ships find it difficult to ove about.

Pipes also serve other purposes than to carry fluids. neumatic pipes transport containers carrying mes-ages. Much of our electrical and telephone wiring runs rough pipes known as conduits, which protect the ires from water and breakage.

Kinds of pipe. Most water pipe larger than 3 inches centimeters) in diameter is made of cast iron, rein-rced concrete, steel, or a mixture of asbestos and ce-ent. Smaller water pipes in buildings may be made of alvanized steel, copper, wrought iron, or a vinyl plastic alled *polyvinyl chloride* (PVC). Gas and oil pipelines are uilt of steel pipe. Cast iron, glazed tile, and concrete re among the materials used for drain and sewer pipe. rigation systems may have lightweight aluminum or VC pipe that can be easily moved. Atomic-power plants ave stainless steel piping. Pipe may be made in several ays, depending on the material and type of pipe de-ired. These ways include molding, casting, welding, nd drawing or pushing the material over a sharp point o make a center hole.

History. People made pipe of clay thousands of years go to carry water. The Romans used lead pipe to con-ect their public fountains to aqueducts. American pio-eers made water systems from logs with holes bored hrough their centers. Later, they made pipes from oops and wooden staves in much the same way bar-els are made. Bobby E. Price

Pipe is a device used for smoking tobacco. People have moked tobacco in pipes for more than 2,000 years. To-acco pipes were brought to Europe during the 1500's y explorers who learned about them from American In-ians. The Indians smoked tobacco during religious cer-monies. The Indians also used the pipe as a symbol of eace.

Pipes consist of two main parts—a bowl and a hollow stem. The bowl holds tobacco, and the stem is connect-ed to the bowl. Smoke from the burning tobacco is drawn into the mouth through the stem. Pipestems are made of plastic, hard rubber, or bone. The most com-mon materials used for bowls are brier (also spelled *bri-ar*), clay, meerschaum, and porcelain. In the United States, some pipes are made of corncobs.

Most pipes are named for the type of material used for the bowl. For example, a brier pipe has a bowl made from the hard wood that comes from the root of the brier shrub. This plant grows in such warm, dry coun-tries as Greece, Italy, and Spain. Most brier pipes are produced in standard shapes and sizes, as well as a style known as *freehand.* Freehand pipes have unusual shapes. Brier pipes are made both by machine and by hand.

Meerschaum pipes are made from a white, claylike substance that is found underground in countries near the Mediterranean Sea. Although meerschaum is frag-ile, it can be carved easily. Meerschaum pipes are craft-ed into beautiful designs, figures, or scenes. The bowls range in length from about 1 inch to 2 feet (2.5 centime-ters to 60 centimeters). Meerschaum changes to a rich brown color after being smoked for some time.



Iwan Ries & Co. (WORLD BOOK photo)

Pipes come in a variety of shapes and sizes and are made from such materials as brier, meerschaum, and porcelain. In the United States, some pipes are also formed from corncobs.

Porcelain pipes are popular in Europe. Many have hand-painted scenes on the bowls, and cherrywood stems. In the Middle East, the *hookah,* or *water pipe,* is popular. The hookah consists of a bowl connected to a vase of water, and a long flexible stem. Before the smoke enters the smoker's mouth, it passes through the water to cool.

People have been collecting smoking pipes for hun-dreds of years, and there are pipe collector clubs throughout the world. Members of these clubs meet to buy, sell, and trade old and new pipes. C. Bruce Spencer

See also **Brier; Meerschaum; Peace pipe; Smoking; Tobacco.**

Pipe organ. See **Organ** (Pipe organs).

Pipe Spring National Monument is in northwest-ern Arizona on the Kaibab Indian reservation. A memori-al to Western pioneer life, it has a historic fort and other structures built by Mormon pioneers. It was established in 1923. For area, see **National Park System** (table: Na-tional monuments).

Pipefish gets its name from its long, slim body, which looks like a tube or pipe. The pipefishes form a group of about 230 species of fishes. Most of them live in temper-ate and warm seas. A few species live in fresh water. Pipefishes are relatives of the seahorse. The body of a pipefish is covered with bony plates. Certain kinds of pipefishes may grow 24 inches (61 centimeters) long. The long snout ends in a small, narrow, toothless mouth.

Male pipefishes have an unusual pouch on the abdo-men in which they carry the eggs. The female fish places the eggs in this pouch, where they hatch. The young



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The pipefish has a long, slim body covered with bony plates. Its long snout ends in a small, narrow, toothless mouth.

pipefishes remain in the pouch until they can care for themselves and are able to leave. John E. McCosker

Scientific classification. The pipefish belongs to the family Syngnathidae.

Pipeline is a system of pipes that transports certain substances over long distances. Pipelines play an important role in the operation and the economy of modern communities. They carry most of the water used in homes, businesses, and industry, and transport natural gas, petroleum, and such petroleum products as gasoline, kerosene, and diesel fuel. They also carry industrial waste and sewage, and particles of coal, iron ore, and limestone used for industrial purposes.

Many pipelines consist of a series of steel pipes welded together. But many gas and water pipelines are made of such plastics as polyethylene and polyvinyl chloride. Pipelines are also made of aluminum, concrete, iron, or a combination of asbestos and cement. Water pipelines are often built in segments connected at joints with watertight gaskets or sealing materials.

A pipeline may be more than 3,000 miles (4,800 kilometers) long. Pipelines range in diameter from about $\frac{1}{2}$ inch (1.3 centimeters) to 15 feet (4.6 meters). Most pipelines are buried at least 2 feet (0.6 meter) underground. Some are laid on the ground or along supports above the ground. Some lines are laid underwater. Pipelines run across deserts, over mountains, and under rivers and lakes.

Pipelines are among the most efficient means of transportation. They deliver large quantities of materials in a continuous flow directly from a supplier to a user. A pipeline 650 miles (1,050 kilometers) long and 40 inches (102 centimeters) in diameter can transport about a million barrels of petroleum a day. Although pipelines are expensive to build, they are relatively cheap to operate and maintain. They distribute more fuels used as energy—chiefly petroleum, petroleum products, and natural gas—than do any other means of transportation.

In the United States, about 227,000 miles (365,000 kilometers) of pipelines carry crude oil and petroleum products to refineries and market areas. Natural gas travels to processing plants and communities through a network of nearly 2 million miles (3,200,000 kilometers) of pipelines. Canada has about 21,000 miles (33,800 kilometers) of petroleum pipelines and approximately 88,000 miles (142,000 kilometers) of pipelines that carry natural gas.

Kinds of pipelines

There are three chief kinds of pipelines: (1) gas pipelines, (2) liquid pipelines, and (3) solids pipelines.

Gas pipelines carry mainly natural gas. Pipes called *gathering lines* transport gas from a well to processing plants. The processed gas is then fed into *transmission pipelines,* which carry it to cities and towns. There, it flows to consumers through *distribution lines.* There are two kinds of distribution lines, *mains* and *individual service lines.* Mains are pipes connected to transmission pipelines. They typically range in diameter from 2 to 24 inches (5 to 61 centimeters). Service lines branch off the mains, and most are 2 inches (5 centimeters) or less in diameter. They carry the fuel sold by utility companies to homes, offices, factories, and other consumers.

Liquid pipelines carry chiefly petroleum, petroleum products, and water. In transporting petroleum, gathering lines take the oil from the well to *trunk pipelines.* Some trunk lines move the oil directly to refineries. Others take it to shipping points for delivery to refineries by tankers, barges, railroad cars, or trucks. The refineries use the petroleum in making gasoline, lubricating oil,



Joel W. Rogers, Earth Images

The Trans-Alaska Pipeline stretches about 800 miles (1,300 kilometers) and taps the oil reserves of Alaska's North Slope. About half the line runs along supports aboveground.

;d other products, which are carried to market areas 1 ough *product pipelines.*

Water-transmission pipelines bring water to cities and 1vns from lakes, reservoirs, wells, and other sources. e water then flows into distribution pipelines, 1 ough mains, and into service lines that lead to build- gs in the community. Pipes inside each building dis- bute the water to faucets, toilets, and other plumbing tures. Another network of pipes carries wastewater ,d sewage from these fixtures through drains and sew- s. Water pipelines also supply water for agricultural d industrial uses, such as in irrigation systems and ning operations.

Solids pipelines transport most materials in the form *slurries,* which are mixtures of liquids and finely ound solid particles. Slurries include coal and water, n ore and water, limestone and water, and coal and l. They flow like liquids, and pipelines that carry slur- s resemble liquid pipelines. Solids pipelines trans- rt certain materials, such as sawdust and wheat, by eans of air flowing through the system.

How pipelines work

Pipelines use tremendous pressure to transport the bstances being carried through them. This pressure ually ranges from 50 to 2,000 pounds per square inch 4 to 1,379 newtons per square centimeter) at the be- nning of the pipeline. It moves natural gas at about 15 iles (24 kilometers) per hour and liquids and slurries at to 5 miles (3 to 8 kilometers) per hour.

As the substance travels through the line, the pres- ire propelling it decreases because of friction of the aterial against the walls of the pipe. Therefore, the ma- rial requires a boost of energy every 30 to 150 miles 8 to 241 kilometers) to push it along. This energy is pplied by *compressor stations* for gas pipelines and *pumping stations* for liquid and slurry lines. The flow material through a pipeline may also be regulated by ntrol valves along the route.

Several materials at a time can be transported by pelines that carry petroleum products. The different aterials are pumped through the line one after the oth- in "batches" at least 15 to 20 miles (24 to 32 kilometers) ng. The materials are arranged so that the most valu- ble substances are separated from the least valuable. is arrangement reduces any damage that may result if me of the products get mixed together. Near the end f the line, an instrument called a *gravitometer* deter- ines the dividing line between products by measuring e differences in their weights.

Pipelines are continually inspected for leaks and for damage caused by such conditions as corrosion, freezing temperatures, heavy rain, and soil erosion. The locations of underground pipelines are marked to prevent damage from any future construction projects. A coating of tar or some other substance helps protect pipelines against corrosion. Special control devices are installed in pipelines to minimize damage to the environment that may be caused by breaks in the line.

Many people believe that pipelines should not be built in certain areas. Environmentalists fought for years to prevent the construction of the Trans-Alaska Pipeline, which opened in 1977. They argued that the pipeline and the heat of the oil traveling through it could upset the delicate ecological balance of the frozen land. Some conservationists oppose the construction of slurry pipelines in the western United States. They believe the limited water resources of the region are needed for agricultural purposes and should not be used in slurry.

Major pipelines of the world

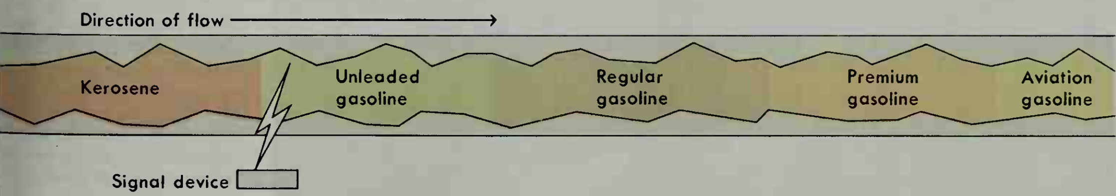
In the United States, an extensive network of pipelines crisscrosses the country. One of the longest of these pipelines carries natural gas from Baton Rouge, Louisiana, to Pittsburgh, Pennsylvania, Philadelphia, and New York City. It is about 2,000 miles (3,200 kilometers) long and has about 8,000 miles (13,000 kilometers) of branch lines.

The Trans-Alaska Pipeline was built to help reduce the nation's fuel shortage by tapping Alaska's vast oil reserves. The pipeline runs about 800 miles (1,300 kilometers) from Prudhoe Bay on the Arctic Ocean in the north to Valdez on the southern coast of Alaska.

In Canada, about 80 percent of the nation's petroleum and natural gas comes from Alberta. Pipelines move these resources to more heavily populated areas. For example, the Interprovincial Pipeline carries oil about 2,500 miles (4,020 kilometers) from Redwater, Alberta, to Montreal, Quebec. The Trans-Canada Pipeline carries natural gas almost 2,300 miles (3,700 kilometers) from the Alberta-Saskatchewan border to Montreal.

In other countries. The nations of the Middle East rely heavily on pipelines to transport the region's huge production of oil. For example, the Trans-Arabia Pipeline runs about 750 miles (1,200 kilometers) across Saudi Arabia between the Persian Gulf and the Red Sea. The pipeline eliminates the need to use the shipping lanes through the Strait of Hormuz, between Oman and Iran.

One of the world's longest pipelines, the Export Pipeline, delivers natural gas more than 4,000 miles (6,400 kilometers), from western Siberia to Austria, Belgium, France, Germany, Italy, and the Netherlands. Another



WORLD BOOK diagram

petroleum products pipeline carries several products at a time by a process called *continu- us batching.* Various signal devices, such as computers and *gravitometers,* indicate where one roduct ends and another begins. A gravitometer distinguishes between products by their weight.

pipeline, eastern Europe's Friendship Pipeline, transports oil about 2,500 miles (4,000 kilometers) from the Ural Mountains in Russia to the Czech Republic, Germany, Hungary, and Slovakia.

The South European Pipeline carries oil nearly 500 miles (800 kilometers) from Lavéra, France, to Karlsruhe, Germany. In China, the oil fields of Manchuria are linked with Qinhuangdao, a port on the Yellow Sea, by a 715-mile (1,151-kilometer) pipeline.

History

The first pipelines of historical importance made up part of the water distribution system of ancient Rome. This system was more than 380 miles (612 kilometers) long and may have carried up to 320 million gallons (1.2 billion liters) of water daily. It was constructed so that the force of gravity carried the water through the system. In 1582, the first pumps for pipelines were installed in the water system of London.

During the mid-1800's, pipelines started to become an important part of the water distribution system of the United States. The nation's first successful oil pipeline was laid in 1865. It carried about 800 barrels of oil a day from an oil field near Titusville, Pennsylvania, to a railroad 5 miles (8 kilometers) away. The first major natural gas pipeline in the United States was completed in New York in 1872. This line delivered gas from West Bloomfield to Rochester, a distance of about 25 miles (40 kilometers). In 1879, a 110-mile (177-kilometer) oil pipeline began to operate in Pennsylvania. This pipeline carried about 10,000 barrels of oil a day from Coryville, near Bradford, to Williamsport.

The pipeline industry grew rapidly after the development of seamless, electrically welded pipe in the 1920's. This kind of pipe was much stronger than earlier types. It could carry materials under greater pressures and, thus, in larger quantities. It enabled gas and oil companies to build profitable pipelines more than 1,000 miles (1,600 kilometers) long. Today, such lines make up a network that carries oil and natural gas from the major producing areas to every part of the United States.

Thomas D. O'Rourke

See also **Coal** (Shipping coal); **Gas** (Transmitting and distributing gas); **Petroleum** (Transporting petroleum); **Water** (City water systems).



WORLD BOOK illustration by Trevor Boyer, Linden Artists L

The American pipit lives in North America and Asia.

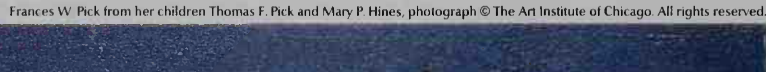
Pipit, *PIHP iht,* is the name of about 35 species of song birds found in most parts of the world. Pipits measure from 5 to 7 inches (13 to 17 centimeters) long. These birds are brownish with dark streaks and white outer ta feathers that show when they fly. Pipits have a character istic graceful walk and a habit of wagging their tail. They feed mainly on insects. Like larks, pipits sing while in flight.

Two species of pipits that live in North America are the *American pipit* and *Sprague's pipit.* The American pipit breeds on *tundras* (treeless plains) of the Far North and on mountaintops in the western part of the United States. It winters in coastal regions of the United States and in Mexico and Central America. It is also found in Asia. Sprague's pipit breeds in short grass prairies from central Canada to the north-central part of the United States, and winters in the Gulf States and Mexico. Both the American pipit and Sprague's pipit build nests of grasses on the ground. The females lay from four to six eggs, which are grayish-white with dark spots.

Martha Hatch Balph

Scientific classification. Pipits belong to the pipit and wagtail family, Motacillidae. The scientific name for the American pipit is *Anthus rubescens.* Sprague's pipit is *Anthus spragueii.*

Pippin, Horace (1888-1946), was an important African American folk painter. Pippin was self-taught as an artist He primarily painted religious themes, war scenes, and



Frances W. Pick from her children Thomas F. Pick and Mary P. Hines, photograph



A Horace Pippin painting shows the blocky, flat forms and rich colors that are typic of the artist's style. This detail of the painting *Cabin in the Cotton* portrays a scene of rural African American life, a common Pippin theme. The oil painting on a wood panel dates from the mid-1930's, ju before Pippin gained nationa recognition as an artist.

ages from African American life. He used rich, often ght colors and painted blocky, flat forms that had no ecific details. Pippin created simple images, and his intings tell easily understood stories.

Pippin was born in West Chester, Pennsylvania, and ew up in Goshen, New York. His grandparents had en slaves. He left school at the age of 14, doing vari s odd jobs to support his ill mother. Pippin was seri sly wounded in the right shoulder while serving in orld War I (1914-1918). The injury left him unable to se his right arm above his shoulder. After the war, he voted himself to painting in West Chester.

Pippin's work first gained recognition in the late 30's, during a revival of interest in American folk art. attracted nationwide attention in 1938, when the Mu um of Modern Art in New York City exhibited four of pictures in a show called "Masters of Popular Paint g." Deborah Leveton

raeus, *py REE uhs* (pop. 179,967), is the third largest y in Greece. Only Athens and Thessaloniki are larger. aeus lies along the Saronic Gulf, 5 miles (8 kilometers) uthwest of Athens (see **Greece** [political map]).

Piraeus has three harbors and is the leading Greek rt. Over half the country's imports and exports pass rough the harbors. Products of Piraeus include alco lic beverages, cement, chemicals, cloth, food prod ts, and metal goods.

Piraeus was an important Greek port in ancient times. the 400's B.C., the Athenians built walls at its harbors d between Piraeus and Athens to protect Athens from vasions. About 450 B.C., the Greek architect Hippoda us created a city plan for Piraeus based on the regular rangement of rectangular city blocks. The plan was e of the great achievements of the Age of Pericles e **Pericles**). In 86 B.C., the Roman general Lucius Cor lius Sulla destroyed the city's harbors. Piraeus then came a small, unimportant village. In A.D. 1834, the eek government restored the harbors, and Piraeus ain grew in size and importance. John J. Baxevanis

irandello, *PIHR uhn DEHL oh,* **Luigi,** *loo EE jee* (1867- 36), an Italian author, won the 1934 Nobel Prize for lit ature. Pirandello is known for his philosophic dramas. e best of his plays argue that reality is unknowable, d that truth varies according to the point of view. He aimed we assume numerous roles or masks in our ily lives, none of them our true self. We should thus wary of passing hasty judgment on others.

Pirandello's best-known play is *Six Characters in earch of an Author* (1921), a fantasy that highlights the p between reality and fiction. *Henry IV* (1922) is a mile one of modern psychological drama that examines the lation between truth and illusion. Pirandello's 1917 ay *Right You Are (If You Think You Are)* is a direct anal is of the relativity of truth. In addition to his 44 plays, randello also published six volumes of poetry and rote more than 300 short stories. The best of his seven vels is probably *The Late Mattia Pascal* (1904).

Pirandello was born in Girgenti (Agrigento), Sicily. He rned a doctorate in philology at the University of onn in Germany in 1891. He married in 1894 and led a ntented life until his wife went insane in 1904. To fi nce her home care, he taught literature at a girls' hool in Rome, enduring his wife's frequent bouts of vi ent jealousy. His turbulent domestic life helped stimulate the emphasis in his dramas on madness, illusion, and the uncertainty of reality. Frederick C. Wilkins

Piranesi, *PEE rah NEH zee,* **Giovanni Battista,** *joh VAHN nee baht TEES tah* (1720-1778), was an Italian printmaker known for his etchings of ancient Roman architecture. His works inspired architects to imitate Roman designs and influenced the neoclassical style in art of the 1700's.

Piranesi's prints of Rome were published in several collections, including more than 200 in *Roman Antiquities* (1756) and 135 in *Views of Rome* (1748-1778). Piranesi often exaggerated the size and grandeur of the ruins in his prints to show his admiration for the Romans. He also used dramatic highlights and dark shadows to create a feeling of mystery, particularly in a series of 16 etchings called *Prisons* (1745, 1760-1761). These pictures show enormous spaces crowded with chains, pulleys, ropes, stone arches, and high staircases. Human figures seem dwarfed and overpowered by the surroundings. Piranesi said he imagined these scenes while he was delirious from a fever. Artists of the Romantic period of the early 1800's admired these dreamlike fantasies.

Piranesi was born in Mogliano, Italy, near Venice. He studied architecture, stage design, drawing, and printmaking as a youth. Elizabeth Broun



Plate VIII from the *Prisons* series; Calcografia dello Stato, Rome (Alinari/Art Resource)

A Piranesi etching from his *Prisons* series shows a dreamlike interior of towering arches and high staircases. The series contrasts with his many detailed scenes of Roman architecture.

Piranha, *pih RAHN yuh,* is a sharp-toothed fish that lives in lakes and rivers throughout most of South America. Piranhas have been described in motion pictures and in legends as vicious, bloodthirsty predators that

can tear a human being to shreds in seconds. In actuality, piranhas rarely have attacked people. However, piranhas can be a serious problem if introduced into other waters, where they will eat large numbers of native fish, amphibians, and other water animals.

There are at least 25 species of piranhas. They have deep bodies that are flattened on the sides. Most piranhas are olive-green to blue-black, with red or orange bellies. The most common species is the *red piranha,* which can grow to nearly 1 foot (30 centimeters) long. All piranhas have razor-sharp teeth that they use to devour a variety of prey. Normally, piranhas swim alone and feed on smaller fish or on seeds or fruit in the water. Occasionally, they swim together in schools. A school of piranhas, like a pack of wild dogs, may attack a much larger animal and bite away pieces of its flesh.



WORLD BOOK illustration by Colin Newman, Linden Artists Ltd.

The piranha has razor-sharp teeth that it uses to attack its prey. Piranhas live in South American rivers and lakes.

Some states prohibit the importation of wild piranhas. However, some fishing enthusiasts value piranhas because the fish are fierce fighters when hooked and are good to eat. Also, some tropical aquarium owners at first enjoy keeping a piranha but later tire of the expense of feeding it. As a result, wild piranhas have been introduced into some rivers and lakes in the United States, particularly in the Southeast. John E. McCosker

See also **Pacu.**

Scientific classification. Piranhas belong to the family Characidae. The red piranha is *Pygocentrus nattereri.*

Pirate is a person who attacks and robs ships. Such robbers have also been called *buccaneers, filibusters, freebooters, ladrones, pickaroons,* and *sea rovers.* Pirates differ from sea raiders known as *privateers.* Pirates were not licensed by any nation, but privateers were licensed by a particular nation during wartime to attack enemy ships. Therefore, privateers were generally not considered pirates.

Pirates have robbed ships and raided coastal towns since ancient times. The greatest period of pirate attacks, or *piracy,* occurred from the 1500's through the 1700's on the Mediterranean and Caribbean seas. The most famous pirates of this age included Henry Morgan, Blackbeard, and William Kidd. Most pirates were men, but a few women became pirates.

Widespread piracy no longer exists. But attacks have occurred in some areas. In the 1980's, for example, pirates carried out numerous attacks against Cambodian and Vietnamese refugees in the Gulf of Thailand.

How pirates lived. People became pirates for various reasons. Sometimes, the harsh conditions of life at sea led honest seamen to desert or mutiny their ships. These men often turned to piracy to survive. Others sought riches or adventure. Many privateers drifted into piracy when wars between nations ended.

Legend, fiction, and motion pictures have helped create an exciting, romantic image of pirates. A typical pirate is portrayed as a fierce-looking man with a beard. He is sometimes handsomely dressed.

In real life, however, most pirates probably led miserable lives. They were often drunk and quarrelsome. Many pirates died of wounds or disease. Some were shot or marooned by their own crews or captured and sentenced to death by authorities.

In spite of their unlawful way of life, most pirate crews developed rules and regulations to govern their ships. Crew members elected a captain and other officers and had a code of punishment for breaking agreements. They also developed pay scales to determine each person's share of the *booty* (stolen goods).

Until about 1700, pirate ships flew a red banner called the *Bloody Flag.* They then began using flags that pictured such objects as skeletons, flaming swords, and hourglasses. The most popular of the new pirate flags showed a white skull and crossbones on a black background. This symbol became known as the *Jolly Roger.*

Ships involved in trade carried weapons in case of attack. But a pirate crew usually outnumbered the other crew and could defeat it in hand-to-hand combat after coming aboard. Pirates seized trading ships by first maneuvering their vessel next to the ship. They boarded by using hooks and ropes to keep the ships together.

Besides robbing ships, pirates also attacked towns. In



WORLD BOOK illustration by David Cunningham

A pirate carried several kinds of weapons, including a pistol, daggers, an ax, and a short, curved sword called a *cutlass.* Most pirates were men.



WORLD BOOK illustrations by David Cunningham

ate flags commonly featured a skull and crossbones. Some o pictured a skeleton, a sword, or an hourglass. The flags at e left are associated with, *top to bottom,* Emanuel Wynne, rtholomew Roberts, and Edward Low. The flags at the right ve not been identified with a particular pirate.

e towns, they murdered innocent people and took isoners. The pirates held some captives for ransom d enslaved others. They sometimes tortured prisoners get information about treasure. There is little evi- nce that they made their victims "walk the plank."

Pirates and privateers of the Mediterranean. uch of the piracy during ancient times occurred along e eastern coast of the Mediterranean Sea. The Roman npire was threatened by pirates who cut off food sup- ies and other imports. In 67 B.C., Roman forces began campaign that rid the area of pirates for some years.

Sea raids flourished on the Mediterranean from the rly 1500's to the early 1800's. But during that period, e raiders were licensed by their governments and ere considered to be privateers, not pirates. This priva- ering resulted partly from a rivalry between Muslims d Christians. Muslim privateers from the Barbary ates, which lay along the coast of northern Africa, amed the Mediterranean and attacked ships of ance, Italy, Spain, and other Christian nations of Eu- pe. These privateers, sometimes called *Barbary cor- irs* or *Barbary pirates,* had bases in Algiers, Tunis, and ipoli. The corsairs also raided coastal towns of West- n Europe. Raids on the Mediterranean continued until ench forces seized the last base in Algiers in 1830. The ost famous corsairs were Occhiali, the brothers Arouj d Khair-ed-Din Barbarossa, and Dragut.

Pirates of the Caribbean and other areas. During e 1500's, competition between Spain and other Euro- an countries to colonize the newly discovered Ameri- s led to an outbreak of piracy on the Caribbean Sea. rates sailed the Caribbean for over 300 years. By 1550, ain controlled the West Indies and large areas of the uth American mainland. As a result, bands of English, Dutch, and French pirates robbed Spain's ships and looted its settlements. Among these robbers were the "sea dogs" sent by Queen Elizabeth I of England to raid Spanish fleets. They included such famous English captains as Sir Francis Drake and Sir John Hawkins. These raiders committed acts of piracy before the queen declared war on Spain and made them privateers.

During the early 1600's, French, English, Dutch, and other European sailors settled on Hispaniola, Tortue Island (also called Tortuga Island), and other Caribbean islands. They raided Spanish ships and towns and soon became known as *buccaneers.* Their numbers grew, and eventually no town was safe along the *Spanish Main,* an area that included the coasts of what are now Colombia and Venezuela. The most famous buccaneer was the Englishman Henry Morgan. In 1671, he led 2,000 other buccaneers in the looting and destruction of Panama City, Panama, the largest Spanish city in Central America. When it suited them, some buccaneers also served as privateers.

During the late 1600's, the buccaneers sought new targets. Some of them carried out raids in Spanish-controlled areas of the Pacific Ocean. About 1690, the buccaneers and other European pirates began attacking the ships of any nation. Some of the pirates sailed to waters near the slave-trading stations of west Africa. Reports of great wealth lured others to the Indian Ocean. Once there, they ambushed ships that carried rich cargoes of silks, spices, jewels, and ivory. Many of these pirates settled among the people of Madagascar, an island that lies east of the African mainland. Perhaps the best known of the pirates associated with Madagascar was the Scotsman William Kidd. Kidd had been sent by England to capture pirates, but instead he became one himself.

European pirates also turned their attention to North America. By 1700, English colonists had established successful trade routes between North America and Europe. A number of pirates set up a base in the Bahamas and attacked many of the ships that followed these routes. The pirates' leaders included Benjamin Hornigold, "Calico Jack" Rackham, and Charles Vane. Pirates who sailed with these men included the women Anne Bonny and Mary Read. But the most notorious pirate of this time was Blackbeard, who used the names Edward Teach and Edward Drummond. Blackbeard terrorized the Carolina and Virginia coasts in 1717 and 1718. A small fleet of ships from Virginia hunted Blackbeard down and killed him in 1718. By the late 1720's, the British Royal Navy had put an end to most of the activities of European pirates throughout the world.

Asian pirates. Beginning in the early 1600's, pirates from countries in Asia attacked European and other trading ships in many Asian waters. For example, Arab pirates operated off India's Malabar Coast, and Malaysian pirates attacked ships in the South China Sea. Pirates from Taiwan and the mainland of China sailed in the waters off China and Japan. By the mid-1800's, however, the navies of Britain and of other countries had cleared the seas of almost all pirates, including those from Asia. Robert C. Ritchie

Related articles in *World Book* include:

Barbarossa
Barbary States
Blackbeard
Bonnet, Stede

Drake, Sir Francis
Kidd, William
Laffite, Jean
Morgan, Sir Henry
Privateer

Additional resources

Cordingly, David. *Under the Black Flag: The Romance and Reality of Life Among the Pirates.* Random Hse., 1996.
Kallen, Stuart A. *Life Among the Pirates.* Lucent Bks., 1999. Younger readers.
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Pirogue, *puh ROHG,* is either a type of dugout canoe or a modern imitation of that kind of craft. People use pirogues for fishing and transportation in the swamps and bayous of southern Louisiana. The traditional Louisiana pirogue is a flat-bottomed boat made from a log. Today, some pirogues are made of plywood and other materials. The boats may be from 10 to 20 feet (3 to 6 meters) long. They have round, flaring sides and a sharp bow. People propel them with paddles or poles.

Pacific Islanders once used a pirogue that had a second hull, called an *outrigger,* to prevent the boat from tipping. They used paddles or a triangular sail to propel the boat. Octavia N. Cubbins

Pisa, *PEE zuh* (pop. 98,928), is an old city of Italy famed for its marble bell tower (see **Leaning Tower of Pisa**). The city lies on both banks of the River Arno. For location, see **Italy** (political map). Pisa has a university founded in 1343 and an academy of fine arts established by Napoleon. The town has valuable art treasures. It is also a manufacturing center. The house where the scientist Galileo was born is in Pisa. Anthony James Joes

Pisano, *pee SAH noh,* **Giovanni,** *joh VAHN nee* (1248?-1314?), was an Italian sculptor and architect. His father, Nicola Pisano, was also a sculptor. Together, they combined the styles of French Gothic art and classical Roman art in works that influenced artists of the Italian Renaissance. Giovanni's masterpiece is a hexagonal pulpit (1301) in the Church of Sant' Andrea at Pistoia. The pulpit is decorated with five panels that portray episodes related to the life of Jesus Christ. The panels show the Gothic influence in their dramatic composition and in the emotional character of the action.

Giovanni was probably born in Pisa. He began his career about 1265, working with his father on a pulpit in the Cathedral of Siena. Many art historians believe that Giovanni later designed the cathedral's front, which combines Gothic elements with the earlier Romanesque style. Vernon Hyde Minor

See also **Sculpture** (Italian Renaissance sculpture; picture).

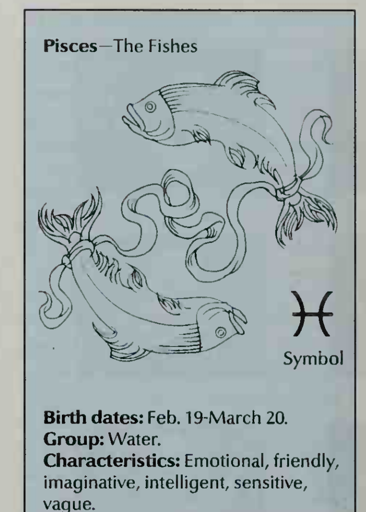
Pisano, *pee SAH noh,* **Nicola,** *nee KAW lah* (1210?-1278?), was an Italian sculptor, as was his son Giovanni. Nicola Pisano's reliefs were created in the classical style that anticipates the art of the Renaissance.

Pisano was probably born in southern Italy and later moved to Pisa. His masterpiece is the six-sided pulpit (1260) in the Baptistery of Pisa. He carved scenes of quiet dignity for the panels, using forms and details borrowed from Roman monuments. In 1268, Pisano finished a large, eight-sided pulpit for the Cathedral of Siena. In this work, Pisano created more dramatic, unified, and action-filled scenes than in his earlier sculptures.

Vernon Hyde Minor

See also **Pisano, Giovanni; Relief.**

Pisces, *PIHS eez* or *PY seez,* is the 12th sign of the zodiac. It is symbolized by two fish. Astrologers believe that



Signs of the zodiac

Aries
March 21-April 19
Taurus
April 20-May 20
Gemini
May 21-June 20
Cancer
June 21-July 22
Leo
July 23-Aug. 22
Virgo
Aug. 23-Sept. 22
Libra
Sept. 23-Oct. 22
Scorpio
Oct. 23-Nov. 21
Sagittarius
Nov. 22-Dec. 21
Capricorn
Dec. 22-Jan. 19
Aquarius
Jan. 20-Feb. 18
Pisces
Feb. 19-March 20

WORLD BOOK illustration by Robert K

Pisces is ruled by two planets, Jupiter and Neptune. Pisces is a water sign.

According to astrologers, people who are born under the sign of Pisces, from February 19 to March 20, are ruled by their emotions, rather than by reason. Pisceans are talented and have vivid imaginations. However, it is difficult for them to make decisions or to solve practical problems. They often retreat from reality into a world of their own dreams and fantasies.

Pisceans are intelligent and friendly people. They have a keen awareness of other people's moods. Pisceans lack the ability to commit themselves to a long-term course of action. Instead, they frequently drift from one interest or project to another. Christopher McIntosh

See also **Astrology; Horoscope; Zodiac.**

Pisgah, Mount. See **Mount Pisgah.**

Pisistratus, *py SIHS truh tuhs* (? -527 B.C.), was a popular ruler of ancient Athens. He employed the poor in such public works programs as building temples and fountains. Pisistratus gained power in 560 B.C., but the Alcmeonid family took control of the city in 556 B.C. Pisistratus went to nearby Macedonia, made a fortune in mining, and formed an army of hired soldiers. His troops took Athens in 546 B.C., and he ruled until his death. Pisistratus encouraged writers and artists. He ordered one of the first collections of Homer's poems to be made. See also **Hipparchus** (ruler); **Library** (Ancient libraries of papyrus). Thomas W. Africa

Pissarro, *pih SAHR oh,* **Camille,** *ka MEE yuh* (1830-1903), was a French Impressionist painter. He was the oldest artist of the Impressionist movement. Pissarro was also probably the most popular and respected member among the Impressionists. He influenced the careers of such artists as Paul Cézanne, Paul Gauguin, and Vincent van Gogh. See **Impressionism.**

Pissarro had a modest disposition, which is reflected in his fondness for painting humble rural scenes and landscapes. His short, patchy brushstrokes give vitality to these commonplace scenes. Pissarro's early paintings emphasize dark tones. He gradually began concentrating on lighter colors, especially after he started to paint



Oil painting on canvas (1870); the Louvre, Paris

Pissarro's paintings typically portray quiet rural scenes. His *Carriage at Louvenciennes* shows the short, patchy brushstrokes he used to paint these subjects. The placement of the figures, house, road, and trees shows how Pissarro carefully organized his compositions.

tdoors in the late 1860's. His pictures show greater ncern with details of rural life and work than those of ost other Impressionists. Pissarro was born on the is- ıd of St. Thomas in the Virgin Islands. Richard Shiff

stachio nut, *pihs TAH shee oh* or *pihs TASH ee oh,* metimes called a *green almond,* is the small seed of e pistachio tree. This tree grows in the eastern Medi- ranean region, in southwestern Asia, and in the uthwestern United States. Growers in California pro- ıce millions of pounds of pistachio nuts each year. A stachio nut may be 1 inch (2.5 centimeters) long. It has smooth, thin, and hard shell that tends to open at the lge. Its thin, smooth husk, or skin, is pale red to yellow. ıe husk is removed before the kernel is processed.

WORLD BOOK illustration by Stuart Lafford, Linden Artists Ltd.

stachio nuts grow in clusters on pistachio trees. The edible een kernel, *right,* has a mild flavor.

The kernel may be eaten as a nut or ground and used as a food flavoring and coloring. The kernel's texture is very fine. Pistachio kernels can be salted while in the shell by placing them in a salty solution. In southwestern Asia and the eastern Mediterranean region, the kernels are pressed for their oil.

The pistachio tree grows well in dry regions. It seldom rises over 30 feet (9 meters) high, but its branches spread widely. Its leaves, which produce a sticky resin, drop off during the winter.

Every pistachio tree is either male or female. In order to produce nuts, the female trees must have a male tree nearby to provide pollen for their flowers.

Richard A. Jaynes

Scientific classification. The pistachio tree is in the cashew family, Anacardiaceae. It is *Pistacia vera.*

Pistil. See **Flower** (The parts of a flower).

Pistol. See **Handgun**.

Piston, *PIHS tuhn,* **Walter** (1894-1976), was a leading American composer. He won the 1948 Pulitzer Prize in music for his Symphony No. 3 (1948) and the 1961 Pulitzer Prize in music for his Symphony No. 7 (1961).

Piston was a member of the neoclassical movement of the early 1900's. His compositions are noted for their skillful orchestrations and expert use of counterpoint (see **Counterpoint**). In addition to eight symphonies, Piston primarily wrote concertos and other works for orchestra as well as many compositions for chamber groups. He composed one work for the stage, a popular ballet called *The Incredible Flutist* (1938).

Piston was born in Rockland, Maine. He studied drawing and painting before choosing a career in music. From 1924 to 1926, he studied in Paris with composer Paul Dukas and the famous teacher Nadia Boulanger. Piston taught music at Harvard University from 1926 to 1960. Leonard W. Van Camp

Pit bull is a name commonly applied to any of several breeds or crossbreeds usually having some mixture of bulldog and terrier. Pit bulls were once used for attack-

ing bulls and bears and for dog-fighting matches. Pit bulls have occasionally attacked, and even killed, human beings. Breeds sometimes called pit bull include the *American pit bull terrier, American Staffordshire terrier, bull terrier, bulldog, bullmastiff,* and *Staffordshire bull terrier,* as well as various crossbreeds.

During the 1980's, the Humane Society of the United States reported that pit bulls were involved in about two-thirds of all deaths resulting from dog bites in the United States. Many people blamed pit bull attacks on the "natural aggressiveness" of the dogs. However, most experts faulted irresponsible owners, who may have abused the dogs or raised them to attack. Many experts also have stressed the difficulty of identifying a dog as a pit bull. According to the American Kennel Club and the United Kennel Club, no dog involved in a fatal attack had been registered by their clubs.

Largely as a result of pit bull attacks, some communities in the United States and Canada have passed laws to protect people from dangerous dogs. Some of these laws prohibit or restrict the ownership of certain breeds. Others require registration and liability insurance for owners of dogs that exhibit unprovoked, aggressive behavior. Michael W. Fox

See also **American Staffordshire terrier; Bull terrier; Bulldog; Bullmastiff; Staffordshire bull terrier.**

Pitcairn Island is a small, isolated island in the South Pacific Ocean. It lies just south of the Tropic of Capricorn and about 5,000 miles (8,000 kilometers) east of Australia. For location, see **Pacific Islands** (map). Pitcairn is famous as the home of the mutineers of the British naval ship *Bounty.*

Pitcairn covers only about 2 square miles (5 square kilometers). The island rises sharply from the sea to an elevation of about 820 feet (250 meters). The interior is rugged, but it has fertile soil. The climate is mild. Average temperatures range from 75 °F (24 °C) in February to 66 °F (19 °C) in August. Rainfall averages 80 inches (200 centimeters) yearly.

Pitcairn is the main island of an overseas territory of the United Kingdom called the Pitcairn Islands Group. The other islands, all uninhabited, are Ducie, Henderson, and Oeno. The British high commissioner to New Zealand heads the territory's government. A council composed of Pitcairn residents directs local affairs.

About 60 people live on Pitcairn. Most of them are descendants of the *Bounty* mutineers and their Polynesian wives. Adamstown is the island's only settlement. Most of the people farm and fish for a living. The main crops are bananas, citrus fruits, coconuts, pumpkins, taro, watermelons, and yams. The people also sell hand-carved wooden figures to passengers of ships that stop at the island. The government gets much of its revenue by selling postage stamps that bear the words "Pitcairn Islands" to collectors.

Pitcairn was inhabited in prehistoric times, probably by Polynesians. However, no one was living there in 1767, when the English navigator Philip Carteret and his crew became the first Europeans to reach it. Carteret named the island after Robert Pitcairn, the crew member who first sighted the island.

In 1789, mutineers led by Fletcher Christian took control of the *Bounty* from Captain William Bligh in the South Pacific. Bligh and 18 nonmutineers were cast adrift in a small boat. In 1790, nine of the mutineers se tled on Pitcairn. These British sailors brought 19 Polyn sians with them—6 men, 12 women, and a young girl. Disputes over women eventually led to fighting amon the men. By 1808, when an American ship discovered the mutineers' hideout, all the men except the mutine John Adams were dead. But the mutineers had left 25 children. In 1856, many of Pitcairn's people moved to Norfolk Island. Robert Langdon

See also **Bligh, William; Nordhoff and Hall; Norfolk Island.**

Pitch. See **Propeller** (Airplane propellers).

Pitch is a black, gluelike substance that is obtained b distilling coal tar. Pitch is highly adhesive and water re pellent. It is used for roofing materials, road pavings, and waterproofing applications. Pitch is also used in making the carbon *electrodes* (electrical poles) for the electrolytic cells that produce aluminum. Bob Willia

See also **Coal tar.**

Pitch is the characteristic of a sound determined by t *frequency of vibration* of the sound waves. High-pitch sounds have higher frequencies than low-pitched sounds. When violin players tune their instruments, th adjust each string so that it will vibrate at the desired f quency.

The pitch of most sounds we hear is actually due to blend of various frequencies. The sounds produced b musical instrument, a whistle, or a siren have several frequencies at the same time. The lowest frequency, called the *fundamental frequency,* is produced by an object vibrating as a whole. The higher frequencies, called *harmonics* or *overtones,* are produced by an ob ject vibrating in parts. For example, a violin string vibrates as a whole, and in halves, thirds, and so on at th same time. The overtones are whole number multiple of the fundamental frequency. A tuning fork produces sound wave of a single frequency. So do pitch pipes, which are used to get the correct number of vibration for certain notes. Physicists distinguish between pitch and frequency. They use the term *pitch* to refer to the psychological judgment of frequency, which depends on the loudness of the tone.

The notes we play and sing today did not always ha the same pitch. Composer George Frideric Handel tuned the A above middle C as low as 422.5 vibrations second. Today, the standard for pitch is the Stuttgart, c concert, pitch. It places A at 440 vibrations a second. Thomas A. Griffy

See also **Harmonics; Music** (Tone); **Sound** (Frequen and pitch).

Pitchblende is a variety of uraninite, a mineral that consists chiefly of uranium and oxygen. The ore is hig radioactive. In 1898, the French physicists Marie and Pierre Curie discovered radium, a rare element used i medicine and the physical sciences, in pitchblende. Pitchblende ranks as a major mineral source of uraniu which is used to produce nuclear energy.

The word *pitchblende* comes from *pitch,* a shiny su stance made from tar. Pitchblende has a tarlike luster and ranges in color from black to dark brown. Countri that have pitchblende deposits include Canada, the Czech Republic, France, Germany, South Africa, and th United States. Robert B. Cook

Pitcher, Molly (1754?-1832), was the fictitious name

ven to a woman who fought in the Battle of Mon-
outh in the Revolutionary War in America (1775-1783).
er real first name was Mary. Her last name, which may
ve been Ludwig, is in dispute. Mary was born near
iladelphia, and went to Carlisle, Pennsylvania, as a
rvant at an early age. She married William Hays, a
oung barber who lived in the village. Her husband en-
ted as a gunner in the First Pennsylvania Artillery in
75 and spent the winter of 1777 and 1778 at Valley
orge. Like many other poor women of the time, Mary
aveled with her husband. She received half-rations in
e Continental Army in return for cooking, washing,
wing, and doing other work.

The Battle of Monmouth was fought on June 28, 1778,
ne of the hottest days of a hot summer. The great heat
nd the fighting made the soldiers very thirsty. Accord-
g to legend, Mary carried water in a pitcher from a
earby spring to her husband's artillery station. The wa-
r was used to swab out the cannon after each shot,
nd to quench the soldiers' thirst. During the battle,
lary's husband fell from a heatstroke. She took his
ace and helped his crew fire the cannon. From these
ctions, she gained the nickname Molly Pitcher, repre-
entative of all women who fought valiantly in the war.

After the war, she and her husband returned to Car-
sle. Several years after Hays's death in 1787, she mar-
ed George McCauly (McCalla). He had been a soldier
the Revolutionary War and a friend of her first hus-
and. In 1822, the Pennsylvania state legislature awarded
lolly Pitcher a yearly pension of $40 in recognition of
er military service. James Kirby Martin

itcher plant is the name of a family of green plants
ith pitcher-shaped leaves that form traps for insects.
tcher plants are called *carnivorous plants* because they
ed on animal life (see **Carnivorous plant**). Like other
reen plants, pitcher plants make their own food by a
rocess called *photosynthesis* (see **Photosynthesis**).
owever, pitcher plants live in places where they get lit-
e nitrogen from the soil. The trapped insects provide
trogen for the plants. These unusual plants have many
cal names. Among these names are *sidesaddle flower, untsman's-cup,* and *Indian dipper.*

The common *northern* pitcher plant grows in
arshes and swamps east of the Rocky Mountains from
abrador south to Florida. The lower edges of its leaves
e folded together to form a tube, or pitcher. The top
dges are left open to form the lid, or spout. Rain water
ollects in these pitchers. Thick bristles grow at the
outh of each pitcher. These bristles all point down-
ard and inward. Tiny honey glands cover the inner sur-
ce of the lid. The smell of the sweet juice attracts in-
ects. Once the insect alights, the bristles prevent its
aving. It slides down to the base of the tube, where it
rowns. After a while, the plant digests the insect.

The globe-shaped flower of the pitcher plant grows
ngly on a long, slender stem. It is a deep reddish-
urple color. The people of the Canadian province of
ewfoundland and Labrador chose the pitcher plant as
eir provincial flower (see **Newfoundland and Labra-
or** [picture: Floral emblem]). A pitcher plant with yellow
owers grows in the Southern States. It has tall, erect,
umpet-shaped leaves. Another species of the pitcher
ant, the *cobra plant,* is native to California. Most in-
ects caught by this plant are killed. However, a certain
moth and a species of mosquito make their home in the
pitcher. Norman L. Christensen, Jr.

Scientific classification. Pitcher plants belong to the sarracenia family, Sarraceniaceae. The northern pitcher plant is *Sarracenia purpurea.* The southern pitcher plant is *S. flava.* The California pitcher plant is *Darlingtonia californica.*

See also **Plant** (picture: Plants that eat insects).

Pitohui, *PIHT oh HOO ee,* is the name of six species of songbirds found only in the forests of New Guinea. The pitohuis include the first known poisonous birds. Pitohuis have strong beaks and legs. Most of the species are sociable and live in small groups.

The feathers and skin of at least three species contain a strong poison. The poison probably keeps the pitohuis from being eaten by predators, such as snakes and hawks. Unlike some poisonous animals, pitohuis only use their poison to protect themselves. They are not known to use it to prey on or attack other animals.

The *hooded pitohui* is the most toxic of the three poisonous species. This bird is about 9 inches (23 centimeters) long. It has an orange-brown body with black wings, head, and tail. Curiously enough, its color pattern resembles that of the monarch butterfly, which is also poisonous and inedible to predators.



WORLD BOOK illustration by Colin Newman

The hooded pitohui is the most poisonous pitohui.

There are no known cases of a pitohui's poison causing serious harm to human beings. However, the village people of New Guinea, who hunt and eat native birds, call the pitohui a "rubbish bird" and rarely eat it.
Bruce M. Beehler

Scientific classification. Pitohuis belong to the tribe Pachycephalini in the subfamily Pachycephalinae, family Corvidae. The scientific name for the hooded pitohui is *Pitohui dichrous.*

Pitt, William (1708-1778), the first Earl of Chatham, was a British statesman. He is chiefly remembered as the "organizer of victory" and empire builder during the Seven Years' War (1756-1763) and for his powerful defense of the rights of the American colonists.

Pitt was born on Nov. 15, 1708, in Westminster. He was the son of a member of Parliament and attended Eton College and Oxford University. In 1735, he entered Parliament. From the first, he distinguished himself by his fiery attacks on Prime Minister Sir Robert Walpole and on the practice of subsidizing troops from the German *electorate* (territory) of Hanover with British money.

Pitt ended his attacks after he was appointed paymaster general of the British military forces in 1746. In this

office, he acquired a reputation for unusual honesty. Eventually, however, he bitterly denounced both the government's war policy and the weakness of its leader, the Duke of Newcastle. This action led directly to Pitt's dismissal in 1755. But he returned to office as secretary of state in 1756, when British military failures during the Seven Years' War led to Newcastle's fall from power. Pitt was again forced from office in 1757, but he returned the same year. "I know," he said, "that I can save this country, and that no one else can."

Pitt's task seemed insurmountable. On every side he found defeat and confusion. However, in five years, Britain gained great success, for which Pitt took the credit. He sent troops and money to Frederick the Great of Prussia and attacked France on all fronts. Great victories, especially in 1759, marked his policy everywhere. The French were defeated in India, America, Europe, and the West Indies, as well as on the sea. But other British ministers opposed Pitt when he demanded that war also be declared on Spain. He resigned as secretary of state in 1761.

During the next five years, Pitt resumed his opposition to the government. He denounced the Peace of Paris (1763) as far too lenient and aroused the British people to criticize the House of Commons. Pitt also denounced British policy toward the American colonists. As a result, he became an extremely popular figure in America.

Pitt was too powerful to remain out of office for long. In July 1766, he became prime minister and had his first opportunity at full control of the government. But his ministry lacked unity, and he lost political influence when he entered the House of Lords as the Earl of Chatham in August. He and his ministers proved incapable of solving troubles in America and India. Although Pitt had been an outstanding wartime leader, he had neither the patience nor the temperament for political cooperation and administration. He also failed to deal successfully with financial problems. Within a few months, Pitt was disabled by mental illness. He resigned his post as prime minister in October 1768.



Bettmann Archive

William Pitt

During the next 10 years, Pitt remained politically ineffective because of poor health. He supported parliamentary reform. He also protested against British policy in America and worked to satisfy grievances. Pitt's commitment to such causes limited his popularity in Britain, and he failed to gain much of a following. But he always remained capable of dominating his listeners, and his last speeches on the American war were among his best. Pitt's son William Pitt the Younger served as prime minister of Britain from 1783 to 1801 and from 1804 to 1806. J. C. D. Clark

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Pitt, William, the Younger (1759-1806), was a Briti statesman. He became Britain's chancellor of the exchequer at the age of 23 and prime minister at 24. He was the youngest person ever to hold either post. Pitt serve as the prime minister of Britain from 1783 to 1801 and from 1804 to 1806. He also dominated British politics b tween those two terms. He was the son of William Pitt, Earl of Chatham, who was also a leading British statesman.

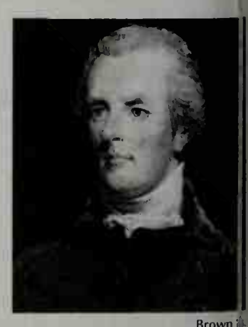
William Pitt the Younger was born in Kent and entered Cambridge University at the age of 14. After grac uation in 1776, he studied law. He was admitted to the bar in 1780, but his main interest lay in politics. In January 1781, Pitt entered Parliament. His amazing abilities quickly made him outstanding. His first speech, always one of the most difficult tests in politics, was remarkable. In committee work, he was informed, penetratin and self-possessed.

Almost immediately, Pitt began to press for parliamentary reform and the reduction of the influence of t king. He quickly gained favor with the older politicians He served as chancellor of the exchequer in 1782 and 1783.

In December 1783, Pitt became prime minister. He held this office for the next 17 years. During the first three months, he experienced great difficulty in the House of Commons because he single-handedly had t meet the attacks of the opposition, led by Charles Jam Fox, Edmund Burke, Richard Brinsley Sheridan, and Lord North. In March 1784, however, Pitt called for a new election and scored a great triumph. This provide him with a majority in the House of Commons.

Pitt then turned his attention to improving the Britis economy. He increased government revenue, funded the national debt, improved the government's credit, and negotiated a free-trade treaty with France. He extended the authority of the British government over India. But Pitt also had troubles. King George III suffere from a disease—probably porphyria—that, beginning i 1788, made him appear to be mentally ill. Pitt had to struggle against a Whig party campaign to name the Prince of Wales as regent. Pitt feared that if the Whigs succeeded, they would take over the government. George's recovery in 1789 relieved the situation.

A more important problem—the French Revolution soon challenged Pitt. At first, he failed to sense its sign icance. But his attitude changed when France declarec war on Britain in 1793. Pitt organized a vast coalition o European countries to fight France. After some succes es, the alliance suffered military defeats. Several nations left the alliance. After the rise of Napoleon Bonaparte in France, the situation grew steadily worse. Pitt entered into peace negotiations with the French government, but was unsuccessful. The dismal end came when Napoleon's triumphs over Austria brought about Austria's withdrawal from the coalition.



Brown

William Pitt the Younge

Britain remained at war with France, and Napoleon in-
ded Egypt in 1798 to destroy British trade with the
iddle East. But after Napoleon had arrived in Egypt, a
itish fleet destroyed his fleet in the Battle of the Nile.
t then helped form a second coalition of nations
ainst France, and the coalition defeated the French
ny in Italy. But Napoleon returned to France and, in
00, scored a decisive victory against the coalition.

Pitt resigned from office in March 1801 after his fail-
e to persuade George III to allow Roman Catholics to
ter Parliament at the time of the Act of Union. The Act
Union had formed the United Kingdom of Great Brit-
n and Ireland earlier in 1801. Pitt returned to office in
04 to organize a third coalition of nations against Na-
leon.

This coalition also fell before the French, and its fail-
e proved disastrous to Pitt. He was sadly troubled al-
ady because of the king's worsening health problems
d his own poor health and disorganized finances. He
uld not survive the military defeats of the United King-
m's allies. Even Admiral Horatio Nelson's astounding
val victory at Trafalgar in 1805 could not make up for
e losses. Though Pitt could say "England has saved
rself by her exertions, and will, I trust, save Europe by
r example," he also recognized the significance of
poleon's victory at Austerlitz. "Roll up the map," he
id of a map of Europe, "it will not be wanted these ten
ars." James J. Sack

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ttsburg Landing, Battle of. See Civil War (Battle Shiloh).

ttsburgh is the second largest city in Pennsylvania.
nly Philadelphia has more people. Pittsburgh lies in the
lling hills of southwestern Pennsylvania, where the Al-
gheny and Monongahela rivers meet and form the
nio River.

During the late 1800's, Pittsburgh became the world's
ading producer of steel. Massive mills turned out steel
r automobiles, ships, trains, and numerous other
oducts. Pittsburgh earned the nickname the *Steel City.*

Steel production gave Pittsburgh a booming econo-
y. It also caused severe pollution, however. Some-
nes, the air became so polluted that during the 1940's,
wntown streetlights had to be turned on during day-
ne. Some people mocked Pittsburgh as the "Smoky
ty." In the early 1950's, Pittsburgh began a major urban
newal program. The program included strict controls
industry and coal-burning furnaces. These steps
eatly reduced pollution in the city.

Most of Pittsburgh's big steel mills are gone. The city
still an important steel producer, but it has a much
ore varied economy than it had in the past. Service in-
istries, especially health and medical, now contribute
eatly to the economy.

Settlers first came to the area that is now Pittsburgh in
e 1750's. The British and the French both claimed the
ea. The area was a scene of fighting between the
itish and French during the 1750's. The British military
ilt a fort there in 1758. They named it Fort Pitt in honor
of William Pitt, who later became Britain's prime minis-
ter. British settlers established a community around the
fort and named it Pittsburgh.

The city

Layout of Pittsburgh. Pittsburgh covers 56 square
miles (145 square kilometers) in the center of Allegheny
County. Much of downtown Pittsburgh lies in a wedge-
shaped area between the fork of the Allegheny and
Monongahela rivers. This area, called the Golden Trian-
gle, features skyscrapers that house offices and shops.
Most of Pittsburgh's major corporations have their
headquarters in or near there. They include Alcoa Inc.,
Mellon Bank, PPG Industries, and United States Steel
Corporation. The 64-story U.S. Steel Tower ranks as one
of the tallest buildings in Pennsylvania.

The western tip of the Golden Triangle—where the
Ohio River begins—is called the Point. Old factories and
warehouses formerly crowded the Point. But those
buildings were torn down at the start of Pittsburgh's ur-
ban renewal program in the 1950's. In their place, devel-
opers established scenic Point State Park and a new of-
fice complex called Gateway Center. Large numbers of
workers commute to and from downtown Pittsburgh,

Facts in brief

Population: *City*—334,563. *Metropolitan area*—2,358,695.
Area: *City*—56 mi² (145 km²). *Metropolitan area*—4,624 mi² (11,976 km²).
Climate: *Average temperature*—January, 29 °F (−2 °C); July, 72 °F (22 °C). *Average annual precipitation* (rainfall, melted snow, and other forms of moisture)—40 in (100 cm). For the monthly weather in Pittsburgh, see **Pennsylvania** (Climate).
Government: Mayor-council. *Terms*— 4 years for the mayor and 9 council members.
Founded: 1758. Incorporated as a city in 1816.

Largest communities in the Pittsburgh area

Name	Population	Name	Population
Pittsburgh	334,563	Ross*	32,551
Penn Hills*	46,809	Shaler*	29,757
Hempfield*	40,721	Monroeville	29,349
Bethel Park	33,556	North Huntington*	29,123
Mount Lebanon*	33,017	McCandless*	29,022

*Township. Source: 2000 census.





Symbols of Pittsburgh. The city flag and coat of arms of Pittsburgh include the crest of the Chatham family, of which William Pitt was the first earl. The castle above the crest represents Pittsburgh as a chartered municipality.



© Jim Sch

Downtown Pittsburgh lies in a triangle-shaped area bordered by two rivers, the Allegheny, spanned by the bridge at the left; and the Monongahela, at the right. Its skyscrapers house most of the city's major corporations. The area at the tip of the triangle is Point State Park.

mostly by automobile. Bridges over the rivers serve the cars. Pittsburgh has more than 450 bridges, more than any other United States city.

A hill called Mount Washington overlooks downtown Pittsburgh. It rises 450 feet (137 meters) and stretches for several miles along the Monongahela River. It features observation decks and restaurants that offer spectacular views of Pittsburgh and its three famous rivers. Two small cable car lines, called "inclines" by Pittsburghers, carry visitors up and down Mount Washington.

The Civic Arena stands just east of Pittsburgh's business area. Its domed roof can be opened so that musical and stage events can be held in the open air when weather permits.

Residential areas spread out beyond downtown. Industrial activity is scattered throughout the region.

The metropolitan area. Pittsburgh's metropolitan area covers Allegheny, Beaver, Butler, Fayette, Washington, and Westmoreland counties. It includes about 200 communities. Penn Hills is Pittsburgh's largest suburb. Other big suburbs include Bethel Park, McCandless, Monroeville, and Mount Lebanon.

The Pittsburgh metropolitan area includes a number of communities which, like Pittsburgh itself, formerly depended on the production of steel. These communities include Duquesne, Homestead, and McKeesport. When their mills closed, the towns suffered economically. Like Pittsburgh, they are working to build a varied economy.

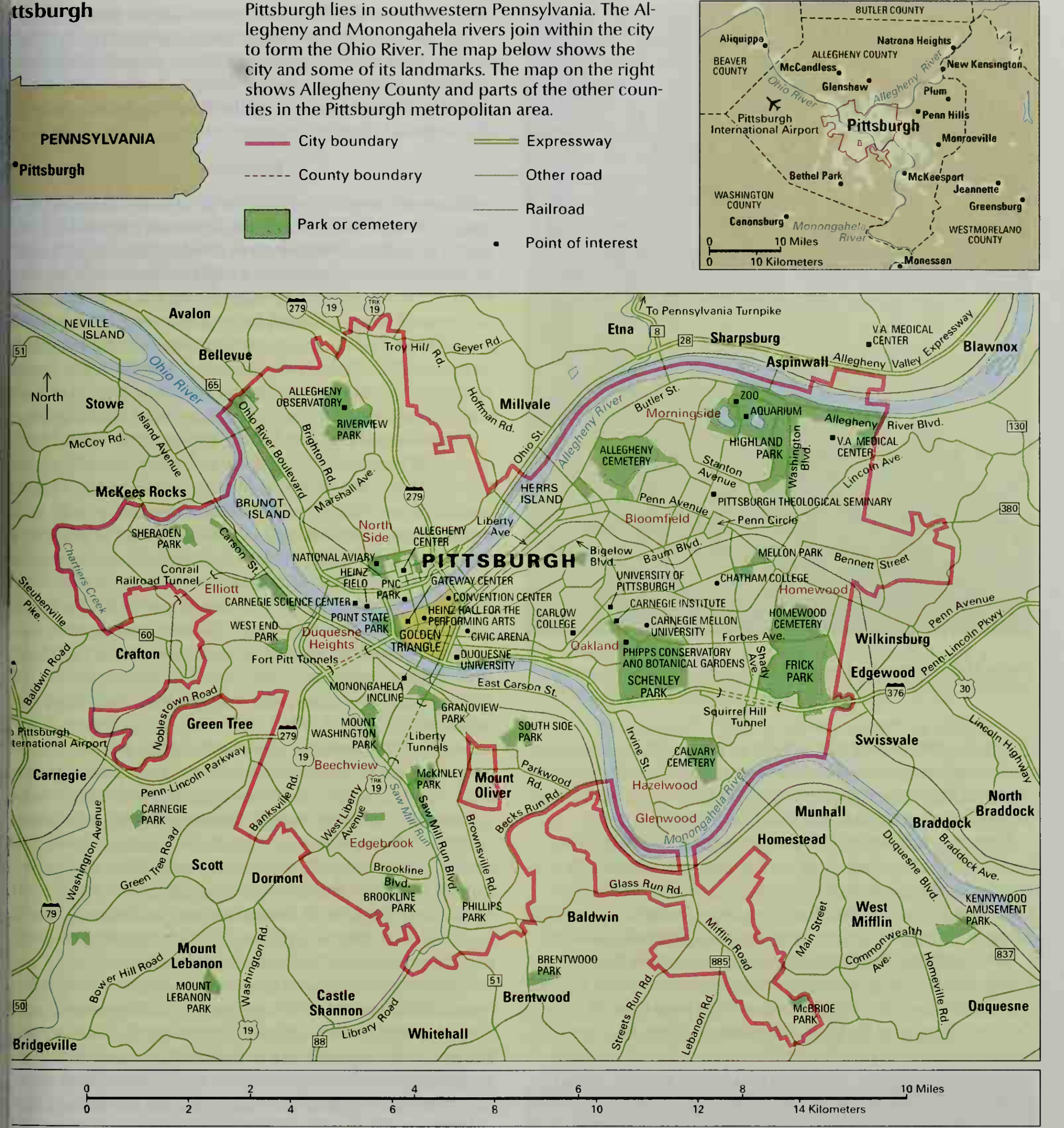
People

Ethnic groups. Early in its history, Pittsburgh attracted people from many parts of Europe. The first settlers came from England. Large numbers of German, Irish, Italian, and Polish people settled in the city during the 1800's. Pittsburgh still has an old neighborhood called Polish Hill, where Polish is spoken as often as English. Many Croats, Hungarians, and Serbs came to work in the steel mills and settled in Pittsburgh about 1900.

African Americans account for approximately a four of Pittsburgh's population. Large numbers of African Americans began moving there in the early 1900's. Fro the 1930's through the 1950's, Pittsburgh's Hill District was one of the most prosperous African American co munities in the United States. Today, many African Americans live near the center of the city. Some black live in the suburbs, including Penn Hills and Wilkinsburg.

Housing. Pittsburgh's East End includes well-kept neighborhoods with housing ranging from relatively i expensive duplexes to lavish mansions. Part of the Nor Side includes houses that are more than 100 years old They have been restored to reflect their original condi tion and beauty. Crawford Square is a development of single-family homes, town houses, and apartments ne the Civic Arena, close to downtown. The city government and private developers worked together to buil it. Some of the older homes near downtown stand on the steep hillsides. The hills are so steep that many buildings are two stories high in front and four or mo stories in back.

Education. The public schools of Pittsburgh serve about 40,000 students. Pittsburgh's Roman Catholic di cese, which covers six counties, has about 35,000 students in its elementary and high schools. The Pittsbur area is also a center of higher education. It includes about 30 colleges and universities. The University of Pittsburgh ranks as the area's largest school of higher



Pittsburgh lies in southwestern Pennsylvania. The Allegheny and Monongahela rivers join within the city to form the Ohio River. The map below shows the city and some of its landmarks. The map on the right shows Allegheny County and parts of the other counties in the Pittsburgh metropolitan area.

WORLD BOOK maps

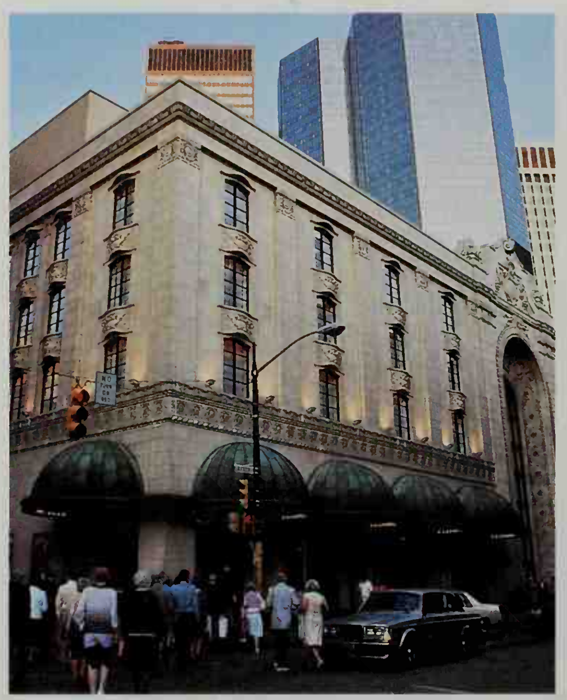
ducation. Other area schools include Carnegie Mellon niversity; Duquesne University; Pittsburgh Theological eminary; and Carlow, Chatham, La Roche, Point Park, nd Robert Morris colleges.

Social problems. Pittsburgh, like other large urban eas, has a number of social problems. They include reet crime and illegal drug sales and use. Pittsburgh rmerly experienced severe air and water pollution. But ontrols and cooperation have led to a major reduction the pollution problem.

Cultural life

The arts. The Pittsburgh Symphony Orchestra presents concerts downtown at Heinz Hall for the Performing Arts. The Benedum Center for the Performing Arts is the home of several groups. They are the Pittsburgh Ballet Theatre, Pittsburgh Opera, Pittsburgh Dance Council, and Civic Light Opera. The Pittsburgh Public Theater offers professional regional theater. The annual Three Rivers Arts Festival, held each June in Point State Park and the Golden Triangle, features works by painters, sculptors, and musicians. The Star Lake Amphitheatre in Washington County presents outdoor concerts.

Museums and libraries. Pittsburgh's Carnegie Institute includes the Museum of Natural History and the Museum of Art. The natural history museum features a collection of dinosaur fossils. The art museum includes the Heinz Architectural Center and Hall of Architecture.



© Jack A. Wolf

Heinz Hall for the Performing Arts, in the downtown area, is the home of the world-famous Pittsburgh Symphony Orchestra.

The Carnegie Science Center presents science shows and other programs. The Andy Warhol Museum houses many of the most famous works by Warhol, a major Pop artist who was born in Pittsburgh.

Carnegie Library of Pittsburgh is the city's public library. It is named for Andrew Carnegie, a Pittsburgh steel manufacturer, who founded it in 1895. The Carnegie Library of Pittsburgh system includes a main library at the Carnegie Institute and several branches.

Recreation. The Pittsburgh area has more than 150 parks, fields, playgrounds, and playlots. Schenley Park is one of Pittsburgh's largest parks. It includes the Phipps Conservatory and Botanical Gardens, which houses a rich collection of plants and flowers in one of the few remaining Victorian greenhouses in the United States. Highland Park is home of the Pittsburgh Zoo and the Aquarium. The National Aviary in Pittsburgh houses about 200 species of birds in a natural setting with plants, pools, and waterfalls. Exhibits at the Pittsburgh Children's Museum encourage personal participation. Suburban areas include several large county parks that offer biking, hiking, horse riding, swimming, and ice skating. Suburban Raccoon Creek State Park, in Hookstown, includes a large lake and a wildflower reserve. Kennywood Amusement Park, in West Mifflin, is famous for its fast roller coasters.

Each August, the Three Rivers Regatta brings spectators downtown to see speedboat races and fireworks. The riverboats of the Gateway Clipper Fleet offer dining, dancing, and sightseeing tours of downtown the year around. Fort Necessity National Battlefield, in Farmington south of Pittsburgh, marks the site of the Battle of Fort Necessity of 1754. The battle was one of the first of the French and Indian War, which began that year.

Pittsburgh is the home of three professional sports teams. They are the Pittsburgh Pirates baseball team of the National League, the Pittsburgh Steelers of the National Football League, and the Pittsburgh Penguins of the National Hockey League.

Economy

The economy of the Pittsburgh area went through a major change in the 1980's. It had been dependent on heavy industry—notably steel production—but it began to develop more variety and balance. Unemployment rose as heavy industry declined, but the development o other economic activities helped improve economic conditions. Today, service industries contribute heavily to the area's economy, employing about 370,000 peopl Health care and retail trade are the largest service indu tries. Manufacturing employs more than 130,000 peopl

Manufacturing. Pittsburgh's steel mills formerly pro duced all kinds of steel. Today's remaining mills chiefly turn out specialty steel, which is used to make tools an automobiles. This type of steel is of higher quality and more profitable than types made in earlier years. Pittsburgh factories also produce glass products, fabricate metals, chemicals, and machinery.

Pittsburgh's largest private employers include Alcoa, the world's biggest aluminum producer; United States Steel Corporation, a leading steelmaker; and PPG Indus tries, a glass, paint, and chemical manufacturer. The H. Heinz Company makes ketchup, pickles, and other foo products.

Service industries. The Pittsburgh area ranks as a major center of health care. About 90 hospitals serve th area. The University of Pittsburgh runs a medical cente specializing in liver, kidney, heart, and lung transplants

Research and development is also a major service in dustry. More than 170 academic, industrial, and govern mental research laboratories operate in the Pittsburgh area. Their engineers, scientists, and technicians work i such fields as medical technology, computer software programming, and industrial automation.

Transportation and communication. Pittsburgh In ternational Airport is in southwestern Allegheny Count Two major railroads and four interstate highways serv the city. A trolley-subway connects downtown with southern suburbs. Pittsburgh's rivers are used to ship raw materials to, and finished products from, the city.

Pittsburgh has one daily newspaper, the morning *Pittsburgh Post-Gazette*. The *Tribune-Review* in nearby Greensburg also publishes a Pittsburgh edition. Severa smaller daily newspapers published in towns surround ing Pittsburgh serve the area's suburban population. KDKA became one of the first commercial radio station in the United States when it began broadcasting in 192 For more details, see **Radio** (The start of broadcasting).

Government

The city of Pittsburgh has a mayor-council form of government. Voters elect the mayor and the nine coun cil members to four-year terms. Most of the city's revenues come from a wage tax and property taxes. In the 1990's, to reduce its spending, the city turned over thre city institutions to private groups to own and manage. The three were the Pittsburgh Zoo, the Phipps Conser

ory and Botanical Gardens, and the National Aviary in ttsburgh. Pittsburgh is the seat of Allegheny County.

In addition to the city government, the Pittsburgh area is dozens of other government bodies. They include iburban municipal governments, local boards of edu- tion, and county government.

History

Early days. In the 1740's, French soldiers claimed the ea that is now Pittsburgh for the king of France. Many dians traded goods with French and Canadian traders. ie Iroquois of western New York had chased the origi- il tribes out of the area in the 1600's.

Both Britain (now the United Kingdom) and France ought to gain control of the region, and this competi- on led to the French and Indian War (1754-1763). In '54, French troops built Fort Duquesne at the fork of e Allegheny and Monongahela rivers. George Wash- gton built Fort Necessity south of Fort Duquesne. 'ashington, later the first United States president, was en a 22-year-old lieutenant colonel in Britain's Virginia ilitia. The French defeated Washington's troops in the ittle of Fort Necessity and forced Washington to sur- nder the fort. The battle marked one of the first mili- ry actions of the French and Indian War.

In spite of their early defeat, the British won control of e Pittsburgh area in 1758. They built Fort Pitt near the rk of the Allegheny and Monongahela rivers. A settle- ent grew up around the fort and became Pittsburgh. ie American colonists won independence from Britain the Revolutionary War (1775-1783). After the war, Pitts- irgh became a starting point for pioneers traveling est. Pittsburgh became the Allegheny County seat in '88 and was incorporated as a borough in 1794.

Industrial development. Demands from Western ttlements for manufactured goods caused industry to ow rapidly in Pittsburgh. The city was incorporated in 16. It then had a population of about 5,000. Nearby de- osits of coal and oil helped make Pittsburgh an iron- aking and glassmaking center by the mid-1800's.

Transportation developments also helped industry ow in Pittsburgh. In 1811, the first steamboat to travel i the Ohio and Mississippi rivers was launched from tsburgh. The Pennsylvania Canal System, which con- cted Pittsburgh and Philadelphia, opened its main line 1834. A railroad entered Pittsburgh in 1851. By then, ore than 46,000 people lived in the city.

The American Civil War (1861-1865) created a great mand for arms and ammunition. Pittsburgh became a ief supplier for the Union Army. During the late 00's, steel manufacturers Andrew Carnegie and Henry ay Frick built industrial empires in the city. Pittsburgh el mills played an important role in America's growth. ey supplied great amounts of steel to build bridges, tories, and railroads. Steady industrial growth attract- thousands of workers to Pittsburgh during the late 00's. Many came from southern and central Europe. om 1870 to 1900, the city's population more than pled, jumping from 86,076 to 321,616. By 1900, half of world's glass and iron came from Pittsburgh's facto- s. The city's steel mills made two-thirds of the steel oduced in the United States by 1900.

The early 1900's. The arrival of more immigrants m Europe and of many blacks from the southern United States helped boost the population of Pittsburgh to 669,817 by 1930. In 1936, the Allegheny and Monongahela rivers flooded the Golden Triangle, causing 74 deaths and damaging thousands of homes.

World War II. In December 1941, the United States joined the side of the Allies in their World War II fight against the Axis nations. From then until the Allied victory in September 1945, the Pittsburgh area's mills and factories operated at full capacity to provide steel, glass, and other products for the war effort. During the war, mills of the Pittsburgh area turned out more steel than did the Axis countries of Germany and Japan combined.

Also during World War II, Pittsburgh became one of the first cities in the United States to construct large amounts of public housing. Thousands of people moved to the city to take jobs in its booming war-related industries. The inflow of people caused a housing shortage and led the city and federal governments to construct low-rent public housing for workers.

Urban renewal. In 1946, Mayor David L. Lawrence, financier Richard K. Mellon, and many other civic and corporate leaders began an urban renewal program in Pittsburgh that would become the first such program in the United States. The city started strict smoke-control and water pollution-control programs to clean up Pittsburgh's polluted air and water. By the 1960's, most of the clean-up efforts had been completed. Pittsburgh's population reached its highest point of 676,806 in 1950. In the 1950's and 1960's, many white residents moved out of the city to surrounding suburbs.

The first stage of urban renewal, known as Pittsburgh's Renaissance I, ended in the early 1970's. The factories and warehouses in the Golden Triangle had been torn down and replaced with Point State Park and Gateway Center in the 1950's. The Civic Arena and the U.S. Steel Tower had been completed in the 1960's. A second project, Renaissance II, began during the 1980's. It produced a convention center, a trolley-subway system, and several new skyscrapers, including PPG Place.

Recent developments. Between 1980 and 1990, the population of Pittsburgh dropped from 423,959 to 369,879, largely because of economic problems. Many young people moved to other cities to find work. During the 1990's, unemployment declined as new jobs in



Archive Photos

Smoke from Pittsburgh's steel mills darkened the skies in this picture from the 1940's, before industry controls reduced air pollution. But steel production also benefited Pittsburgh's economy.

health care and other occupations became available. Pittsburgh International Airport opened in 1992, adding to the area's role as a transportation center. Despite these developments, Pittsburgh's population fell again between 1990 and 2000, to 334,563. Bill Steigerwald

Related articles in *World Book* include:

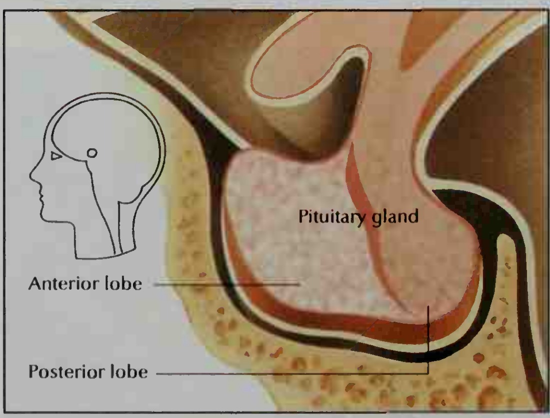
Allegheny River	Mellon, Andrew W.
Carnegie, Andrew	Monongahela River
Fort Duquesne	Pittsburgh, University of
Fort Necessity	

Pittsburgh, University of, is a privately controlled, state-supported school in Pittsburgh. The university offers programs in liberal arts and sciences and in numerous professions, including medicine, law, library and information science, engineering, and social work. It has 14 graduate and professional schools and over 25 specialized research centers. It is an important health center and is known worldwide for its organ transplant program. Courses lead to bachelor's, master's, and doctor's degrees. The university also has campuses in Bradford, Greensburg, Johnstown, and Titusville. It was founded in 1787. Critically reviewed by the University of Pittsburgh

Pituitary gland, *pih TOO uh TEHR ee,* is one of the body's most important glands. It secretes a number of hormones, which control a wide range of body functions. The pituitary gland, also called the *hypophysis,* is about the size of a pea and lies under the brain near the center of the skull. A short stalk connects the pituitary to the *hypothalamus,* a part of the brain.

The pituitary has two main sections—the *anterior lobe* (front part) and the *posterior lobe* (rear part). The anterior lobe secretes several hormones. Four of these hormones control the secretions of other hormone-producing glands. The four hormones and the glands they control are *adrenocorticotropic hormone* (ACTH), the adrenal glands; *follicle-stimulating hormone* (FSH) and *luteinizing hormone* (LH), the sex glands; and *thyroid-stimulating hormone* (TSH), the thyroid gland. Secretions from these glands, in turn, signal the pituitary to decrease secretion of the hormones controlling them.

The anterior lobe of the pituitary also produces *growth hormone* (GH), which regulates the growth of children and adolescents. Growth hormone also helps



WORLD BOOK illustration by Leonard Morgan

The pituitary gland is one of the body's chief hormone-producing organs. It consists of two main parts—the anterior and posterior lobes—and it rests in a bony depression at the base of the brain. A short stalk connects the pituitary to the brain.

control the way food is utilized in people of all ages. *Pr lactin,* another hormone of the anterior lobe, stimulates milk production in nursing mothers. The hypothalamus plays an important role in regulating the anterior lobe of the pituitary. It produces *releasing hormones* that govern the release of secretions from the anterior lobe.

The posterior lobe of the pituitary gland stores two hormones, *antidiuretic hormone* (ADH, also called *vaso pressin)* and *oxytocin.* The hypothalamus manufactures and triggers the release of both these hormones. Antidiuretic hormone causes the kidneys to retain sufficient water for the body. Oxytocin causes the uterus to contract during childbirth and stimulates the release of mil during nursing. Charlotte H. Greene

Related articles in *World Book* include:

ACTH	Giant	Human body (Trans-Vision)
Dwarf	Gland	Hypothalamus
Endorphin		

Pius IV (1499-1565) was elected pope in 1559. He successfully put into effect many key reform measures of the church renewal movement called the Counter Refo mation. His major achievement was reconvening the Council of Trent. The council had been suspended in 1552, and Pius reopened it in 1562. Pius was a shrewd and diplomatic man, and he used these qualities to help the council complete its business in 1563. The council established the basic framework of Roman Catholic reform (see **Trent, Council of**). Pius also reformed the Roman Curia, the pope's administrative arm.

Pius helped revive the cultural and intellectual life of Rome and had several notable structures built, including the Porta Pia arch and the Villa Pia in the Vatican ga dens. In his endeavors, Pius relied on the aid of his nephew, Saint Charles Borromeo.

Pius was born March 31, 1499, in Milan, Italy. His given and family name was Giovanni Angelo de' Medici. H died on Dec. 9, 1565. Charles L. Stinger

Pius V, Saint (1504-1572), was elected pope in 1566. H typified the intense religious feeling of Roman Catholicism during the church renewal movement called the Counter Reformation. Pius was solemn, devout, and ascetic. As pope, he tried to impose rigid standards of piety and morality on clergy and lay people. He worked to put into effect the reforms established by the Counc of Trent by publishing the Roman Catechism and other important devotional documents (see **Trent, Council o**

Pius was an uncompromising enemy of Protestantism He was equally determined to stop the advance of Isla He formed the Holy League with Venice and Spain that won a dramatic victory over the Muslim Ottoman Empire at the Battle of Lepanto in 1571.

Pius was born on Jan. 17, 1504, in Bosco, Italy, near Alessandria. His given and family name was Michele Ghislieri. He died on May 1, 1572, and was *canonized* (declared a saint) in 1712. His feast day is April 30.

Charles L. Stinger

Pius VII (1742-1823) was elected pope of the Roman Catholic Church in 1800. He was pope during the difficult years that Napoleon I of France controlled much o central and western Europe, and during the European settlement that followed Napoleon's defeat in 1815. At first, Pius followed a conciliatory policy with Napoleon He made an agreement with Napoleon that settled the confused French religious problem. The agreement

ıided church-state relations in France for over 100 ıars. In 1804, Pius crowned Napoleon emperor in Paris. However, as Napoleon increased his demands, Pius ffened his resistance. He refused to join the continen- blockade against England, and he refused to grant ıpoleon a divorce from Josephine. In 1809, Napoleon nexed the Papal States. Pius excommunicated all who ok part in this action. He was arrested and held in Fon- nebleau until 1814. Pius's strong stand against Napole- ı won him the admiration of the European powers. ıey supported his bid to reclaim the Papal States after ıpoleon's defeat.

Pius was born on Aug. 14, 1742, in Cesena, Italy. His ven and family name was Gregorio Luigi Barnaba ıiaramonti. He became a Benedictine monk at the age 14. Pope Pius VI named him a cardinal in 1785. Pius VII ed on Aug. 20, 1823. Gerald P. Fogarty

us IX (1792-1878) was elected pope of the Roman ıtholic Church in 1846. He enjoyed the longest reign in pal history. His early acts as pope promised a liberal d popular government for the Papal States. He par- ıned political prisoners, admitted lay people to the ıvernment, and promised a constitution. He fled Rome 1848 when revolutionists made the city a republic. ter his restoration in 1850, Pius followed a highly con- rvative policy in government matters.

In 1854, Pius defined the doctrine of the Immaculate ınception of the Virgin Mary as an article of Roman tholic dogma (see **Immaculate Conception**). Ten ars later, he issued the *Syllabus of Errors,* a collection propositions that gave the impression that Pius was ıposed to all progress and to modern civilization.

The outstanding event of Pius IX's reign was the as- mbling of Vatican Council I in 1869, the first general uncil since the 1500's. The council declared that the pe had *primacy of jurisdiction*—that is, he was first in portance—over the whole church. The council also proved the doctrine of *papal infallibility.* For a descrip- n of this doctrine, see **Vatican Council I.**

Italy took the Papal States and Rome by force during ı unification in the 1860's and 1870's. Pius became a luntary prisoner in the Vatican. He refused any accord ıt did not recognize him as a sovereign ruler. He be- ved that he would be looked on as "the Italian king's aplain" if he settled for less. See **Italy** (Italy united).

Pius was born on May 13, 1792, in Senigallia, Italy. His ven and family name was Giovanni Maria Mastai- rretti. He was ordained a priest in 1819, created an chbishop in 1827, and made a cardinal in 1840. As chbishop of Imola, he was noted for his liberal sympa- es and his criticism of the conservative Pope Gregory I. Pius died on Feb. 7, 1878. Gerald P. Fogarty

us X, Saint (1835-1914), was elected pope of the Ro- ın Catholic Church in 1903. Pius was theologically nservative. In 1907, he issued an *encyclical* (letter to ı entire church) and other statements condemning *odernism.* Modernism was a general trend to adopt w theological methods and to apply historical criti- m to the Scriptures. Pius had an important impact on tholic spiritual life. He encouraged frequent reception the Eucharist, admitted children of the age of reason Communion, and encouraged the use of the Gregori- chant in the liturgy.

Pius was born on June 2, 1835, in Riese, Italy, near Tre- viso. His given and family name was Giuseppe Melchi- orre Sarto. He was ordained a priest in 1858. In 1893, Pope Leo XIII named him patriarch of Venice and a car- dinal. Pius was widely regarded as a saint during his life- time. He died on Aug. 20, 1914, and was *canonized* (de- clared a saint) in 1954. Gerald P. Fogarty

See also **Roman Catholic Church** (Pius X).

Pius XI (1857-1939) was elected pope of the Roman Catholic Church in 1922. In 1929, he negotiated the Lat- eran Treaty that ended a long conflict between the papa- cy and the Kingdom of Italy called the "Roman question." The treaty gave the pope sovereignty over Vatican City (see **Papal States**). Pius was increasingly confronted by the rise of totalitarian governments in Europe. In 1931, he issued an *encyclical* (letter to the entire church) con- demning Italian Fascism. He negotiated a *concordat* (agreement) with Nazi Germany in 1933 but condemned Nazism and Communism in separate encyclicals in 1937. However, in 1936, he supported dictator Francisco Fran- co in the Spanish Civil War against the republican gov- ernment's increased persecution of the Catholic Church.

Pius was born on May 31, 1857, in Desio, Italy, near Milan. His given and family name was Ambrogio Dami- ano Achille Ratti. He was ordained a priest in 1879, and Pope Benedict XV named him a cardinal in 1921. Pius died on Feb. 10, 1939. Gerald P. Fogarty

Pius XII (1876-1958) was elected pope of the Roman Catholic Church in 1939. He was one of the most active popes in church history. Pius used his authority to such an extent that he was sometimes criticized within his church for determining too many issues. But he also was widely praised for the broad range of his interests and his brilliance in attacking basic problems of the church.

Pius negotiated with the heads of several European nations to try to prevent World War II, and to end the war as soon as possible after it began in 1939. He is credited with secret arrangements that saved tens of thousands of Jews from death by the Nazis. After his death, some people blamed Pius for not speaking out more forcefully against Nazi persecution of Jews. Other people believe Pius felt further appeals to Adolf Hitler were useless and that such appeals might have in- creased Nazi persecution of Jews in Italy and elsewhere.

In the area of church teaching, Pius in 1950 pro- claimed the Assumption of the Blessed Virgin into heav- en. His *encyclicals* (letters to the entire church) covered a wide range of topics. *Divino Afflante Spiritu* (1943) opened the way for Catholic Biblical scholarship. *Media- tor Dei* (1947) prepared for the updating of the Catholic Mass in the 1960's. Pius altered some customs, such as shortening Holy Week ceremonies and relaxing the law of fasting before Holy Communion.

Pius was born on March 2, 1876, in Rome. His given and family name was Eugenio Pacelli. He was ordained a priest in 1899 and was named a cardinal in 1929. He served as papal secretary of state from 1930 until his election as pope. Pius died on Oct. 9, 1958.

Gerald P. Fogarty

See also **Pope** (picture: Pius XII).

Additional resources

McInerny, Ralph M. *The Defamation of Pius XII.* St. Augustine's Pr., 2001.

Phayer, Michael. *The Catholic Church and the Holocaust, 1930-1965.* Ind. Univ. Pr., 2000.

Pizarro, *pee THAHR roh* or *pih ZAHR oh,* **Francisco,** *frahn THEES koh* or *frahn SIHS koh* (1478?-1541), was a Spanish conqueror. His conquest of the Inca empire in Peru opened the way for Spain's colonization of most of South America.

Early life. Pizarro was born in Trujillo, Spain. His father was a royal captain of infantry. Francisco's parents never married each other. Poor relatives of his mother raised the boy, who never learned to read. In 1502, Pizarro left for the West Indies. He lived for a while in Hispaniola, the main Spanish base in the New World.

First expeditions. In 1509, Pizarro left Hispaniola to take part in exploration of the Caribbean coast of northern South America and southern Central America. He served as Vasco Nunez de Balboa's chief lieutenant when Balboa marched across the Isthmus of Panama to the Pacific Ocean in 1513 (see **Balboa, Vasco Nunez de**). Six years later, the Spaniards founded Panama City on the Pacific coast. Pizarro was one of its wealthiest and most powerful citizens.

The Spaniards in Panama City became interested in reports of a rich Indian empire somewhere to the south. In 1524, Pizarro began the first of several expeditions to search for this empire. He was helped by another Spaniard, Diego de Almagro, who served chiefly as business manager of the expeditions. Pizarro led the explorations down the Pacific coast. At first, bad weather and Indian attacks prevented the voyagers from finding the empire, which was centered in what is now Peru. Pizarro finally reached his goal in late 1527 or early 1528.

Conquest of Peru. Pizarro saw much evidence of gold and other riches in Peru. He soon returned to Spain, and King Charles I appointed him governor of Peru. In 1531, Pizarro sailed from Panama City with about 180 men. They landed in what is now Ecuador. In 1532, they founded San Miguel (now Piura) in northern Peru.



Detail of *Pizarro Seizing the Inca of Peru* (1846), an oil painting by Sir John Everett Millais (Bridgeman Art Library)

Francisco Pizarro conquered the Inca empire in western South America for Spain. This picture shows him capturing the Inca ruler Atahualpa in a famous battle at Cajamarca in 1532.



WORLD BOOK m

Pizarro's expeditions led to the Spanish conquest of the Inca empire in 1533. Pizarro began to look for the empire in 1524 an finally found it in Peru about four years later.

Pizarro next advanced to Cajamarca, where the Inca ruler Atahualpa had gathered his forces. In a surprise a tack with swords, horses, and a few guns, Pizarro's me captured Atahualpa and killed thousands of Inca. The Spaniards promised to spare Atahualpa's life in return for vast riches. The Inca were able to agree to the ransom because Peru had more silver and gold than any other part of the Americas. But in 1533, after receiving large treasure, the Spaniards executed Atahualpa (see **Atahualpa**). Pizarro then advanced southward to Cusco the Inca mountain capital. The conquerors took contro of the city later in 1533.

Later life. In 1535, Pizarro founded the city of Lima and made it Peru's capital. While he was governor of Peru, many Spaniards settled there. The settlers starte mining great amounts of silver and gold and began to build many cities. Using Peru as its base, Spain conquered most of the rest of South America.

In the late 1530's, a dispute between Pizarro and Almagro over who was to rule the area around Cusco le to war. Pizarro's forces won the conflict in 1538 and ex cuted Almagro. On June 26, 1541, followers of Almagr son killed Pizarro. James Lockhart

See also **Inca** (History); **Peru** (History).

Additional resources

Bernhard, Brendan. *Pizarro, Orellana, and the Exploration of th Amazon.* Chelsea Hse., 1991.

Marrin, Albert. *Inca & Spaniard: Pizarro and the Conquest of Peru.* Atheneum, 1989.

Pizza is a popular food made by baking a flat bread dough topped with cheese, tomato sauce, and herbs. Most pizzas are topped with other ingredients as well. Popular toppings include Italian sausage, mushrooms, onions, pepperoni, and peppers.

Pizza is made in many different forms. *Neapolitan pi za* is thin and round. *Sicilian pizza* is rectangular and thick. In a *Chicago style pizza,* layers of toppings fill a high-edged crust in a deep pan. A *New York style pizz* has a thin crust with a thick, puffy outer edge. A *calzo* is folded pizza dough baked with the toppings inside.

People of ancient Middle Eastern and Mediterrane cultures made an early form of pizza by baking bread with simple toppings on stones in a wood-fired oven.

t pizza as we know it today originated in Naples, Italy. 1889, Raffaele Esposito, a baker, created a special dish honor the visiting king and queen of Italy, Umberto d Margherita. Esposito topped Neapolitan flat bread th green basil, white mozzarella cheese, and red nato sauce to reflect the colors of the Italian flag. any bakers soon copied the dish. John G. Reilly

(U. See **Phenylketonuria**.

ace value. See **Numeration systems**.

acebo, *pluh SEE boh,* is a substance that doctors metimes use as a medicine, even though it contains active ingredient. A placebo brings about an im- ovement or even a cure in some patients. Placebos ok like real drugs but contain only inactive substances, ch as sugar. Doctors also may administer placebo in- ctions, which usually contain salt water or sterile wa- , and may even perform placebo surgery.

Doctors believe the effectiveness of placebos de- nds on the patient's belief that the substance is really edicine. In many cases, this belief provides a psycho- gical boost that can improve the patient's symptoms. A isting relationship between the patient and doctor can crease the placebo's effectiveness. There is also some idence that *endorphins* and other neurochemicals ay a part in the placebo effect. Endorphins may be the dy's natural pain relievers. In 2001, though, a scientific idy found that placebos have little or no actual effect.

Placebos are used in research to help determine the ectiveness of new drugs. One group of patients re- ives the drug. Another group of patients with the me illness, called the *control group,* gets a placebo. e placebo and the drug look alike. Neither the pa- nts nor the doctors know which is the placebo and hich is the drug. Placebo groups are important in stud- of diseases with symptoms that worsen or improve er time, such as arthritis or depression. Researchers rn if a new drug is effective by comparing the effects the drug with those of the placebo.

Physicians have also used placebo groups to test the ectiveness of some surgical operations, such as hroscopic knee surgery to treat osteoarthritis. In such ts, a number of patients are sent to the operating om and put to sleep. A surgeon makes an incision in the patients, but only half actually have the surgical eration. Patients and caregivers are not told if real rgery was performed until after the study is complet- . Melanie Johns Cupp

acenta, *pluh SEHN tuh,* is a disk-shaped organ that velops in pregnant women. The placenta provides the born baby with food and oxygen and carries away the by's waste products. The organ also produces chemi- ls called *hormones,* which maintain the pregnancy d help regulate the baby's development.

The placenta consists of tissue from both the mother d the embryo. After the first week of pregnancy, the ibryo fastens itself to the wall of the *uterus,* the organ which the baby develops. The placenta forms as the erine lining is penetrated and broken down by col- ns of cells from the *chorion,* the baglike covering it encloses the embryo. Inside the columns are blood ssels that branch into tiny, fingerlike projections led *villi.* The villi, which contain the baby's blood, are rrounded by the mother's blood. The blood of the by and of the mother do not mix.

Food and oxygen from the mother's blood pass through the thin walls of the villi and enter the baby's blood through a vein in the *umbilical cord,* a flexible tube connecting the baby to the placenta. Waste prod- ucts from the baby are carried through arteries in the umbilical cord and pass through the villi. The mother's circulatory system then gets rid of these wastes.

The placenta expands in size until about 20 weeks. At that time, it covers about half of the internal surface of the uterus. After 20 weeks, the placenta becomes thicker but not wider. At the end of a nine-month pregnancy, it is about 6 to 8 inches (15 to 20 centimeters) in diameter and about 1 to 1 $\frac{1}{4}$ inches (2.5 to 3.0 centimeters) thick. It weighs about 14 to 21 ounces (400 to 600 grams).

Minutes after the baby is born, the placenta separates from the uterus. Powerful contractions of the uterus ex- pel the placenta, also called the *afterbirth,* from the mother's body. Lois Kazmier Halstead

See also **Reproduction, Human.**

Placentia, *pluh SEHN shuh,* Newfoundland and Labra- dor (pop. 4,426), is the site of an early French settlement in North America. It lies in the southeast corner of the is- land of Newfoundland, about 63 miles (101 kilometers) southwest of the provincial capital, St. John's. See **New- foundland and Labrador** (political map). Placentia was the French headquarters from 1662 until Newfoundland was given to Britain (now the United Kingdom) by the Peace of Utrecht in 1713. The town has ruins of the old French forts, and French and Basque tombstones dating from the 1600's. It is a popular tourist resort with excel- lent salmon fishing in nearby streams. Simon M. Evans

Placid, Lake. See **Lake Placid**.

Plagiarism, *PLAY juh rihz uhm,* is the act of present- ing another person's literary, artistic, or musical work as one's own. For example, a student who copies from ref- erence books has committed plagiarism. A work need not be identical to the original to be a plagiarism. But it must be so similar that it has obviously been copied.

Plagiarism is regarded as unethical. The copyright laws of many nations make plagiarism and other unau- thorized copying a crime punishable by fine or impris- onment. In addition, the creator of a copyrighted work may sue anyone who plagiarizes it. Educational institu- tions prohibit plagiarism, and a student who plagiarizes will be subject to disciplinary penalties.

Plagiarism does not include the adoption of character types, general plots, or other ideas from existing works. Nearly all writers and artists do such borrowing, but they express the ideas in new ways. The great English playwright William Shakespeare took most of his plots from published historical and literary works. But he changed the borrowed materials into works that were uniquely his own. Plagiarism also does not normally in- clude the copying allowed under the *fair use principle* of the copyright law. This principle permits limited re- production of another person's work without permis- sion for such purposes as teaching, research, news re- porting, or criticism. In most cases, the author of the original work should be named. Kent Dunlap

See also **Copyright; Intellectual property.**

Plague, *playg,* is both the name of a serious infectious disease caused by the bacterium *Yersinia pestis* and a term used to describe epidemics generally. This article discusses the disease caused by *Y. pestis.* The bacterium

is named after French scientist Alexandre Yersin, who first identified it in Hong Kong in 1894. Since early times, epidemics of plague have killed hundreds of millions of people. Plague bacteria infect rodents, such as rats, ground squirrels, and prairie dogs. The bites of fleas transmit the germs from rodent to rodent and from rodents to human beings or pets.

Forms of plague. The three main forms of plague are (1) bubonic, (2) septicemic, and (3) pneumonic. Bubonic plague is by far the most common form. It results when a person is bitten by an infected flea. The plague bacteria invade lymph nodes near the bite, causing painful swellings called *buboes.* The buboes usually appear in the legs, neck, armpits, or groin. Plague is called septicemic when the bacteria infect the bloodstream and spread to other parts of the body. Pneumonic plague occurs when the bacteria infect the lungs. It is the most dangerous form because patients can spread the bacteria easily to others by coughing.

Symptoms of plague develop from one to eight days after infection. Symptoms include high fever, rapid pulse, headache, body aches, and weakness. Antibiotics are effective against plague if given soon after infection. Unless treated, plague patients deteriorate rapidly, and most die within five days.

History of plague. Medical historians have identified many epidemics of plague based on written descriptions and paintings of people with buboes. Perhaps the earliest such description is the *plague of Ashdod,* which occurred about 1000 B.C. and is described in the Bible.

In the mid-500's A.D., an epidemic that was almost certainly plague struck the Byzantine Empire and spread from the Black Sea across Europe, killing as much as half the population of Constantinople (now Istanbul, Turkey). Historians later called this the first *pandemic* (worldwide occurrence) of plague.

A second pandemic, often called the "Black Death," swept across Asia and Europe in the mid-1300's. It probably began in Central Asia early in the 1300's. Trading ships carried infected rats west to the Mediterranean Sea. From there, plague spread through most of Europe. By 1400, it had killed 20 million to 30 million people.

A third pandemic began in China in the mid-1800's. Over the next 75 years, plague spread to every inhabited continent and killed up to 20 million people. Plague reached San Francisco in 1899, and later other ports, via ships. Health professionals eventually controlled plague in U.S. cities, but plague-infected wild rodents spread from California to many western states, where several cases still occur each year.

Today, plague occurs occasionally throughout the world, with 1,000 to 2,000 cases reported annually. The bacteria flourish mainly in rural areas, including the western United States, central and southern Asia, Afric South America, and nations bordering the Caspian Se Since the 1990's, public health experts have become in creasingly concerned about plague because it has potential for use in biological weapons. D. Peter Drotman

See also **Epidemic; Flea; London** (War, plague, and fire); **Races, Human** (The clinical approach); **Rat.**

Plaid. See **Tartan.**

Plain is a broad, nearly level stretch of land with no abrupt changes in elevation. Plains are generally lower than the land around them. They may be found along a coast or inland. Coastal plains usually rise from sea lev until they meet higher land forms, such as mountains plateaus. Inland plains may be found at high altitudes.

Climate controls plant life on plains. Thick forests us ally thrive on plains in humid climates. Grasslands cov fairly dry plains, such as the Great Plains in the United States. Plains are usually well populated because the soils and terrain are good for farming and because roads and railroads are easy to build on level land.

Coastal plain is a stretch of lowland along a seacoas which slopes gently toward the sea. In many cases, su a plain may be an elevated part of the ocean floor. Soli materials carried off by rivers or waves form other coastal plains. These materials are deposited along the shore, extending the coast seaward.

Flood plain is the floor of a river valley, beyond the riverbed. A flood plain is formed of mud, sand, and sil left by the overflow of a river. These materials are carried off by the river as it *erodes* (wears away) the land upstream. A river in flood can carry a large amount of eroded material, which the overflow waters deposit onto the flood plain. David S. McArthur

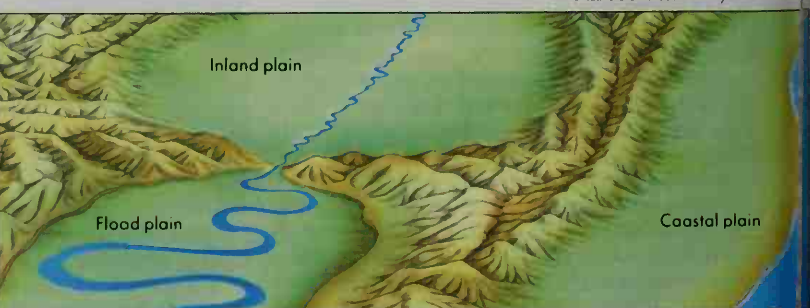
Related articles in *World Book* include:

Fall line	Pampa	Prairie	Tundra
Great Plains	Plateau	Steppe	

Plains Indians. See **Indian, American** (Indians of th Plains; pictures).

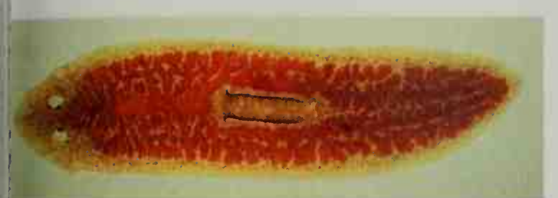
Planarian, *pluh NAIR ee uhn,* is a type of flatworm. Different kinds of planarians live in streams, lakes, sea water, or damp soil. Most planarians have flat, elongated bodies with a rounded or triangular head and measure 7 to 35 millimeters (about $\frac{1}{4}$ to 1 $\frac{1}{2}$ inches) lon Some planarians living in soil may grow as long as 35 centimeters (about 1 foot) and may have green, yellow or black stripes. Most planarians are gray, brown, or black. Many planarians have two dark, cup-shaped ey

WORLD BOOK illustration by Sarah Wood



Kinds of plains

This illustration shows some of the chief kinds of plains. *Coastal plains* are lowlands that slope gently toward the sea. *Inland plains* occur in the interior of a land mass, usually at higher altitudes than coastal plains. *Flood plains* are formed of mud, sand, and silt left by the overflow of a river.



Eric Gravé, Science Photo Library

n enlarged view of a planarian shows the worm's "eyes," hich do not form images as true eyes do. The planarian's feed- g tube, *center,* is on the underside of its extremely thin body.

hese eyes can detect light and dark, but they cannot orm images as the eyes of many other animals do.

Planarians feed on other small animals or on dead an- nal matter. Grooves or pits on each side of the head an sense food.

Planarians lay fertilized eggs in cocoons. The young orms that hatch look like small adult worms. Many pla- arians can also reproduce by simply dividing into ieces. Each piece of the worm then can develop into a omplete new adult. Planarians have remarkable abilities) *regenerate* (regrow) any lost or damaged parts of ieir bodies. Seth Tyler

Scientific classification. Planarians belong to the order Tri- adida of the class Turbellaria in the phylum Platyhelminthes.

lanck, *plahngk,* **Max Karl Ernst Ludwig** (1858- 947), was a German theoretical physicist who concen- ated on the study of thermodynamics. He was con- erned with the phenomena of absorption and emission f heat and other kinds of radiant energy. In 1900, Planck riginated the *quantum theory* when he proposed his w of radiation. This new theory revolutionized the field f physics. In 1918, Planck was awarded the Nobel Prize ır physics.

The major concept involved in Planck's theory was ıat an object that completely absorbs radiant energy, ıown to scientists as a *black body,* can only absorb or nit energy in tiny irreducible bits called *quanta.* The ıergy of each quantum is measured by multiplying the equency of the radiant energy, ν, by a universal con- ant, *h.* The constant is known as *Planck's constant.* hus, energy *(E)* equals *hν*. For example, a red flame nits less energy—that is, it is cooler—than a blue flame ecause red light has a lower frequency than blue light.

Planck's concept of quanta disagreed with former leas about energy. Scientists had thought that energy owed continuously. This view, however, could not ex- lain the absorption and emission of energy by matter. anck's theory accounted for this phenomenon.

In 1905, the German-born physicist Albert Einstein in- ependently introduced the concept of light quanta (see nstein, Albert). In 1913, Danish physicist Niels Bohr in- oduced quantum ideas into atomic theory and origi- ıted the modern theory of atomic structure (see **Bohr,** iels).

Planck was born in Kiel, Germany. He studied at the ıiversities of Munich and Berlin, and taught physics at e universities of Munich, Kiel, and Berlin.

Roger H. Stuewer

See also **Light** (Quantum mechanics); **Quantum me- ıanics; Radiation** (The quantum theory).

lane. See **Airplane.**

lane geometry. See Geometry.

Planet

Planet is a large, round heavenly body that orbits a star and shines with light reflected from the star. We know of nine planets that orbit the sun in our solar system. Since 1992, astronomers have also discovered many planets orbiting other stars.

All but two of the planets in our solar system have smaller objects revolving around them called *satellites* or *moons.* Our solar system also contains thousands of smaller bodies known as *asteroids.* The asteroids are often called minor planets, and the term *major planet* is used to distinguish the nine planets from the asteroids. The remainder of this article uses *planet* to mean *major planet.*

The usual order of the planets in our solar system, outward from the sun, is Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto. To help remember the order, some people use the phrase *My Very Educated Mother Just Sent Us Nine Pizzas* as a memory aid. The initial letters of the words in that phrase match the initial letters of the planet names.

Pluto is not always the farthest planet from the sun, however. Its orbit is such a long oval that Pluto moves inside the path of Neptune for about 20 years every 248 years. One such 20-year period lasted from Jan. 23, 1979, to Feb. 11, 1999.

The planets in our solar system can be divided into two groups, except for Pluto. The innermost four planets—Mercury, Venus, Earth, and Mars—are small, rocky worlds. They are called the *terrestrial* (earthlike) planets, from the Latin word for Earth, *terra.* Earth is the largest terrestrial planet. The other earthlike planets have from 38 percent to 95 percent of Earth's diameter and from 5.6 percent to 81 percent of Earth's *mass* (total quantity of matter).

The next four planets—Jupiter, Saturn, Uranus, and Neptune—are called *gas giants* or *Jovian* (Jupiterlike) *planets.* They have gaseous atmospheres and no solid surfaces. All four Jovian planets consist mainly of hydrogen and helium. Smaller amounts of other materials also occur, including traces of ammonia and methane in their atmospheres. They range from 3.9 times to 11.2 times Earth's diameter and from 15 times to 318 times Earth's mass. Jupiter, Saturn, and Neptune give off more energy than they receive from the sun. Most of this extra energy takes the form of *infrared* radiation, which is felt as heat, instead of visible light. Scientists think the source of some of the energy is probably the slow compression of the planets by their own gravity.

The ninth planet, Pluto, is only 18 percent the diameter of Earth and $\frac{1}{500}$ of its mass. As a small, rocky planet with a larger orbit than the gas giants, it does not fit in either group. Some astronomers think that Pluto may not be a major planet at all.

Observing the planets

People have known the inner six planets of our solar system for thousands of years because they are visible

Jay M. Pasachoff, the contributor of this article, is Field Memorial Professor of Astronomy and Director of the Hopkins Observatory at Williams College.

from Earth without a telescope. The outermost three planets—Uranus, Neptune, and Pluto—were discovered by astronomers, beginning in the 1780's. All three can be seen from Earth with a telescope.

To the unaided eye, the planets look much like the background stars in the night sky. However, the planets move slightly from night to night in relation to the stars. The name *planet* comes from a Greek word meaning *to wander.* The planets and the moon almost always follow the same apparent path through the sky. This path, known as the *zodiac,* is about 16° wide. At its center is the *ecliptic,* the apparent path of the sun. If you see a bright object near the ecliptic at night or near sunrise or sunset, it is most likely a planet. You can even see the brightest planets in the daytime, if you know where to look.

Planets and stars also differ in the steadiness of their light when viewed from Earth's surface. Planets shine with a steady light, but stars seem to twinkle.

The twinkling is due to the moving layers of air that surround Earth. Stars are so far away that they are mere points of light in the sky, even when viewed through a telescope. The atmosphere bends the starlight passing through it. As small regions of the atmosphere move about, the points of light seem to dance and change in brightness.

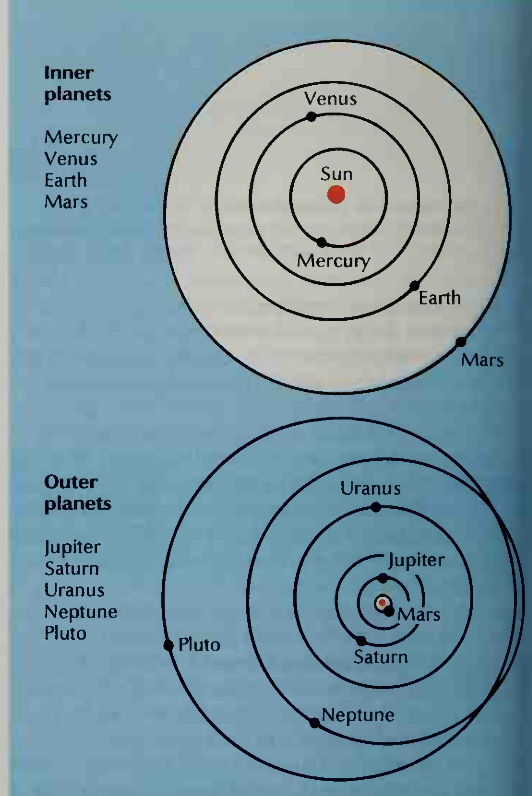
Planets, which are much closer, look like tiny disks through a telescope. The atmosphere scatters light from different points on a planet's disk. However, enough light always arrives from a sufficient number of points to provide a steady appearance.

How planets move

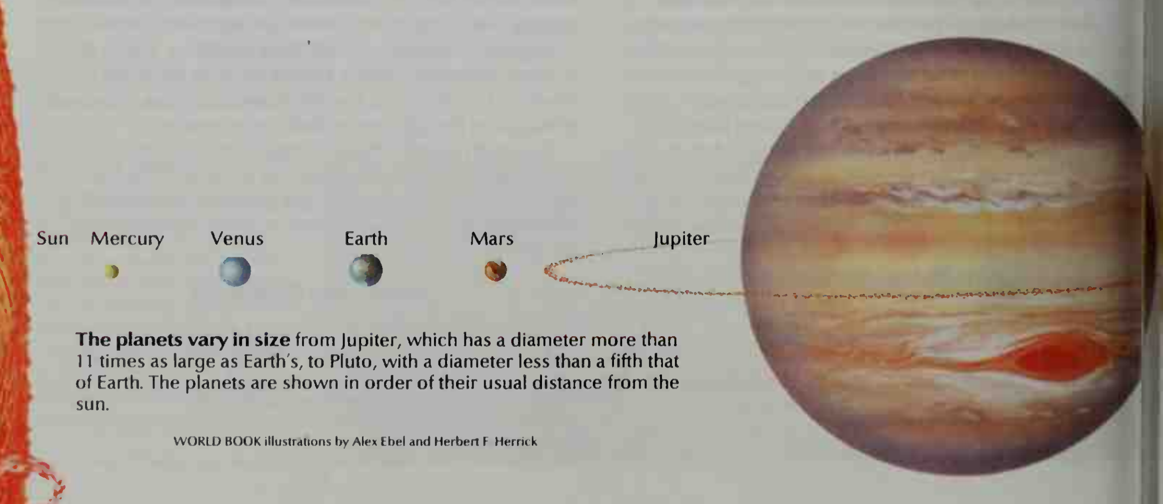
Planets move in two main ways. They travel around their parent star in paths called *orbits.* As each planet orbits its star, it also rotates on its *axis,* an imaginary line through its center.

Orbits. Viewed from Earth's surface, the planets of the solar system and the stars appear to move around Earth. They rise in the east and set in the west each night. Most of the time, the planets move westward across the sky slightly more slowly than the stars do. As a result, the planets seem to drift eastward relative to the background stars. This motion is called *prograde.* For a while each year, however, the planets seem to reverse their direction. This backward motion is called *retrograde.*

In ancient times, most scientists thought that the moon, sun, planets, and stars actually moved around Earth. One puzzle that ancient scientists struggled to explain was the annual retrograde motion of the planets. In about A.D. 150, the Greek astronomer Ptolemy developed a theory that the planets orbited in small circles, which in turn orbited Earth in larger circles. Ptolemy

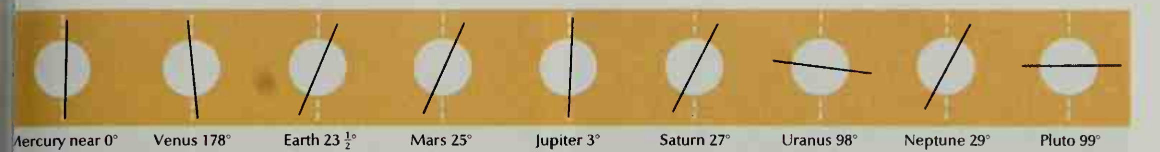


The orbits of the planets around the sun are shown here. Two diagrams are needed because the orbits of the outer planets would extend off the page if they were drawn to the same scale as those of the inner planets.



The planets vary in size from Jupiter, which has a diameter more than 11 times as large as Earth's, to Pluto, with a diameter less than a fifth that of Earth. The planets are shown in order of their usual distance from the sun.

WORLD BOOK illustrations by Alex Ebel and Herbert F. Herrick



The axes of the planets, represented by the solid lines, are imaginary lines around which the planets rotate. A planet's axis is not perpendicular to the path of the planet's orbit around the sun. It is at an angle from the perpendicular position indicated by the broken line.

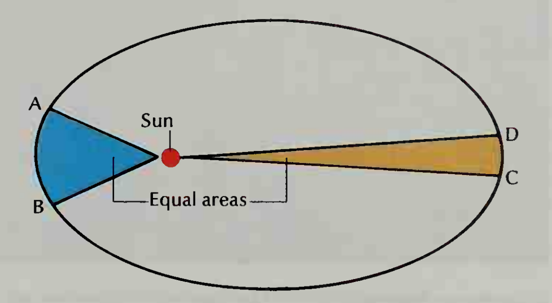
thought that retrograde motion was caused by a planet moving on its small circle in an opposite direction from the motion of the small circle around the big circle.

In 1543, the Polish astronomer Nicolaus Copernicus showed that the sun is the center of the orbits of the planets. Our term *solar system* is based on Copernicus's discovery. Copernicus realized that retrograde motion occurs because Earth moves faster in its orbit than the planets that are farther from the sun. The planets that are closer to the sun move faster in their orbits than Earth travels in its orbit. Retrograde motion occurs whenever Earth passes an outer planet traveling around the sun or an inner planet passes Earth.

In the 1600's, the German astronomer Johannes Kepler used observations of Mars by the Danish astronomer Tycho Brahe to figure out three laws of planetary motion. Although Kepler developed his laws for the planets of our solar system, astronomers have since realized that Kepler's laws are valid for all heavenly bodies that orbit other bodies.

Kepler's first law says that planets move in *elliptical* (oval-shaped) orbits around their parent star—in our solar system, the sun. An *ellipse* is a closed curve formed around two fixed points called *foci.* The ellipse is formed by the path of a point moving so that the sum of its distances from the two foci remains the same. The orbital paths of the planets form ellipses, with the parent star at one focus of the ellipse. Before Kepler, scientists had assumed that the planets moved in circular orbits.

Kepler's second law says that an imaginary line joining the parent star to its planet sweeps across equal areas of space in equal amounts of time. When a planet is close to its star, it moves relatively rapidly in its orbit. The line therefore sweeps out a short, fat, trianglelike

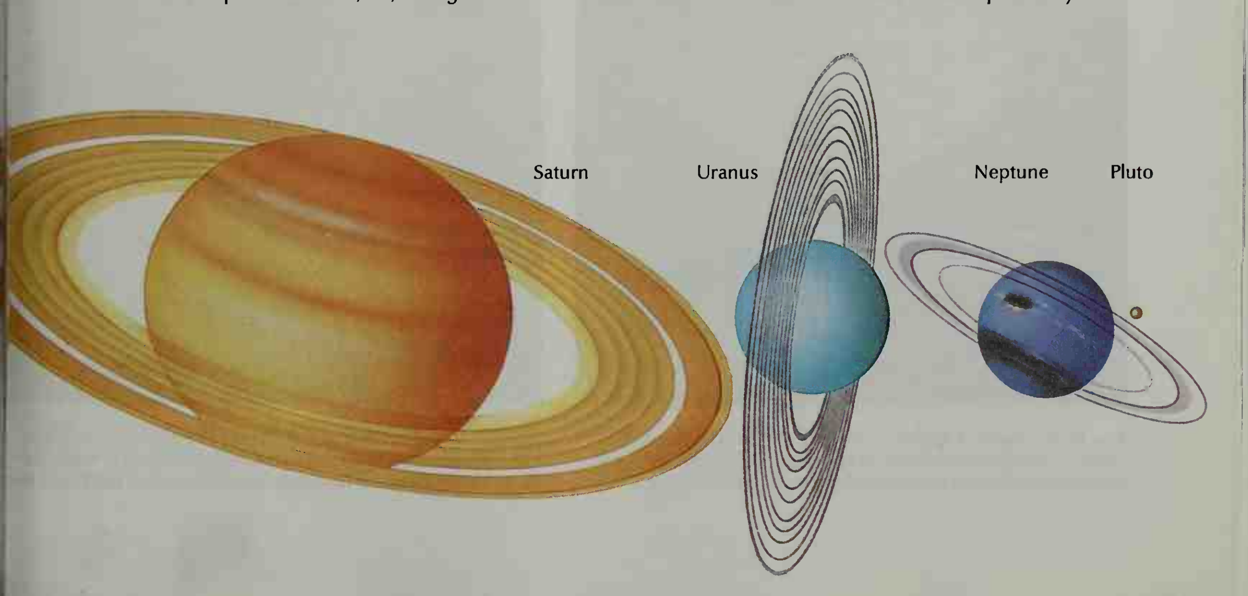


Kepler's second law shows how a planet covers equal areas of its orbit in equal lengths of time. The planet travels at a higher speed near the sun, from *A* to *B*, than far from the sun, *C* to *D.*

figure. When the planet is farther from its star, it moves relatively slowly. In this case, the line sweeps out a long, thin figure that resembles a triangle. But the two figures have equal areas.

Kepler's third law says that a planet's *period* (the time it takes to complete an orbit around its star) depends on its average distance from the star. The law says that the square of the planet's period—that is, the period multiplied by itself—is proportional to the cube of the planet's average distance from its star—the distance multiplied by itself twice—for all planets in a solar system.

The English scientist, astronomer, and mathematician Isaac Newton presented his theory of gravity and explained why Kepler's laws work in a treatise published in 1687. In the treatise, Newton showed how his expanded version of Kepler's third law could be used to find the mass of the sun or the mass of any other object around which things orbit. Using Newton's explanation, astronomers can determine the mass of a planet by




NASA/JPL/MSSS

A canyon on Mars is Earthlike in appearance. However, numerous craters produced by the impact of meteorites give the surface near the edge of the canyon a pitted, unearthly look.


NASA/JPL

The Great Red Spot of Jupiter is one of the most spectacular features in the solar system. This swirling mass of gas, which resembles a hurricane, is about three times as wide as Earth.

studying the period of its moon or moons and their distance from the planet.

Rotation. Planets rotate at different rates. One day is defined as how long it takes Earth to rotate once. Jupiter and Saturn spin much faster, in only about 10 hours. Venus rotates much slower, in about 243 earth-days.

Most planets rotate in the same direction in which they revolve around the sun, with their axis of rotation standing upright from their orbital path. A law of physics holds that such rotation does not change by itself. So astronomers think that the solar system formed out of a cloud of gas and dust that was already spinning.

Uranus and Pluto are tipped on their sides, however, so that their axes lie nearly level with their paths around the sun. Venus is tipped all the way over. Its axis is almost completely upright, but the planet rotates in the direction opposite from the direction of its revolution around the sun. Most astronomers think that some other objects in the solar system must have collided with Uranus, Pluto, and Venus and tipped them.

The planets of our solar system

Astronomers measure distances within the solar system in *astronomical units* (AU). One astronomical unit is the average distance between Earth and the sun, which is about 93 million miles (150 million kilometers). The inner planets have orbits whose diameters are 0.4, 0.7, 1.0, and 1.5 AU, respectively. The orbits of the gas giants are


NASA/JPL

The blue clouds of Neptune are mostly frozen methane, the main chemical in natural gas—a fuel used for heating and cooking on Earth. The other object shown is Neptune's moon Triton.


NASA/JPL

A river of lava on Venus split in two as it flowed from left to right, producing a delta like those made by rivers of water on Earth. Venus's surface has many long channels of hardened lava

uch larger: 5, 10, 20, and 30 AU, respectively. Because their different distances from the sun, the tempera-re, surface features, and other conditions on the plan-s vary widely.

Mercury, the innermost planet, has no moon and al-ost no atmosphere. It orbits so close to the sun that mperatures on its surface can climb as high as 800 °F 30 °C). But some regions near the planet's poles may always in shadow, and astronomers speculate that ater or ice may remain there. No spacecraft has visited ercury since the 1970's, when Mariner 10 photo-aphed about half the planet's surface at close range.

Venus is known as Earth's twin because it resembles rth in size and mass, though it has no moon. Venus s a dense atmosphere that consists primarily of car-n dioxide. The pressure of the atmosphere on Venus's rface is 90 times that of Earth's atmosphere. Venus's ick atmosphere traps energy from the sun, raising the rface temperature on Venus to about 860 °F (460 °C), t enough to melt lead. This trapping of heat is known the *greenhouse effect.* Scientists have warned that a nilar process on Earth is causing permanent global arming. Several spacecraft have orbited or landed on enus. In the 1990's, the Magellan spacecraft used dar—radio waves bounced off the planet—to map enus in detail.

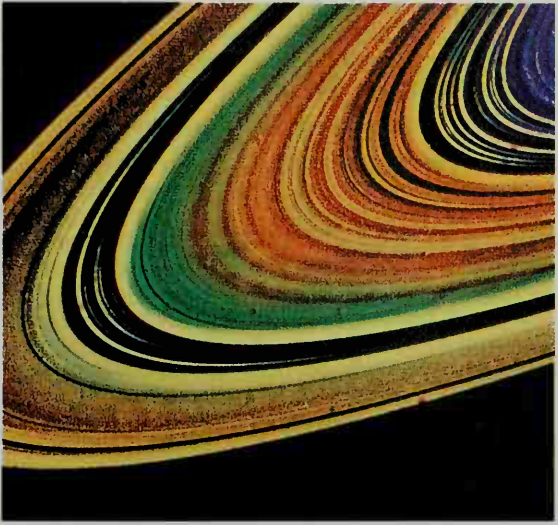
Earth, our home planet, has an atmosphere that is ostly nitrogen with some oxygen. Earth has oceans of uid water and continents that rise above sea level. any measuring devices on the surface and in space onitor conditions on our planet. In 1998, the National eronautics and Space Administration (NASA) launched e first of a series of satellites called the Earth Observ-g System (EOS). The EOS satellites will carry remote-nsing instruments to measure climate changes and her conditions on Earth's surface.

Mars is known as the red planet because of its red-sh-brown appearance, caused by rusty dust on the artian surface. Mars is a cold, dry world with a thin at-osphere. The *atmospheric pressure* (pressure exerted the weight of the gases in the atmosphere) on the artian surface is less than 1 percent the atmospheric essure on Earth. This low surface pressure has en-led most of the water that Mars may once have had to cape into space.

The surface of Mars has giant volcanoes, a huge sys-m of canyons, and stream beds that look as if water wed through them in the past. Mars has two tiny oons, Phobos and Deimos. Many spacecraft have land-l on or orbited Mars.

Jupiter, the largest planet in our solar system, has ore mass than the other planets combined. Like the her Jovian planets, it has gaseous outer layers and may ve a rocky core. A huge storm system called the Great ed Spot in Jupiter's atmosphere is larger than Earth d has raged for hundreds of years.

Jupiter's four largest moons—Io, Europa, Ganymede, d Callisto—are larger than Pluto, and Ganymede is so bigger than Mercury. Circling Jupiter's equator are ree thin rings, consisting mostly of dust particles. A ir of Voyager spacecraft flew by Jupiter in 1979 and nt back close-up pictures. In 1995, the Galileo space-aft dropped a probe into Jupiter's atmosphere and ent into orbit around the planet and its moons.



NASA/JPL

The rings of Saturn consist of billions of pieces of ice, ranging in size from particles the size of dust grains to chunks over 10 feet (3 meters) wide. The rings are shown here in false color.

Saturn, another giant planet, has a magnificent set of gleaming rings. Its gaseous atmosphere is not as color-ful as Jupiter's, however. One reason Saturn is relatively drab is that its hazy upper atmosphere makes the cloud patterns below difficult to see. Another reason is that Saturn is farther than Jupiter from the sun. Because of the difference in distance, Saturn is colder than Jupiter. Due to the temperature difference, the kinds of chemi-cal reactions that color Jupiter's atmosphere occur too slowly to do the same on Saturn.

Saturn's moon Titan is larger than Pluto and Mercury. Titan has a thick atmosphere of nitrogen and methane. In 1980 and 1981, the Voyager 2 spacecraft sent back close-up views of Saturn and its rings and moons.

The Cassini spacecraft will orbit Saturn in 2004. It will also drop a small probe into Titan's atmosphere.

Uranus was the first planet discovered with a tele-scope. German-born English astronomer William Her-schel found it in 1781. He at first thought he had discov-ered a comet. Almost 200 years later, scientists detected 10 narrow rings around Uranus when the planet moved in front of a star and the rings became visible. Voyager 2 studied Uranus and its rings and moons close-up in 1986.

Neptune was first observed in 1846 by German as-tronomer Johann G. Galle after other astronomers pre-dicted its position by studying how it affected Uranus's orbit. In 1989, Voyager 2 found that Neptune had a storm system called the Great Dark Spot, similar to Jupiter's Great Red Spot. But five years later, in 1994, the Hubble Space Telescope found that the Great Dark Spot had vanished. Neptune has four narrow rings, one of which has clumps of matter. Neptune's moon Triton is one of the largest in the solar system and has volcanoes that emit plumes of frozen nitrogen.

Pluto. Tiny, distant Pluto has been difficult to study because it is so far from Earth. The American astrono-mer Clyde W. Tombaugh discovered Pluto in 1930. Only in 1978, when astronomers discovered a moon orbiting

Pluto, could they determine the planet's mass. They found that Pluto was much less massive than expected. The Hubble Space Telescope found a dozen areas of contrasting light and dark on Pluto.

Planets in other solar systems

How planets are detected. Even with the most advanced telescopes, astronomers cannot see planets orbiting other stars directly. The planets shine only by reflected light and are hidden by the brilliance of their parent stars. The planets and their stars are also much farther away than our sun. The nearest star is 4.2 light-years away, compared to 8 light-minutes for the sun. One *light-year* is the distance that light travels in one year—about 5.88 trillion miles (9.46 trillion kilometers). Thus, it takes light 4.2 years to reach Earth from the nearest star beyond the sun and only 8 minutes to reach Earth from the sun.

Astronomers know of more than 50 stars other than the sun that have planets. Scientists detected those planets from tiny changes in the stars' movement and tiny decreases in the amount of light coming from the stars.

The changes in a star's movement are caused by the slight pull of the planet's gravity on its parent star. To find new planets, astronomers use a technique called *spectroscopy,* which breaks down the light from stars into its component rainbow of colors. The scientists look for places in the rainbow where colors are missing. At these places, dark lines known as *spectral lines* cross the rainbow. The spectral lines change their location in the rainbow slightly as a star is pulled by the gravity of an orbiting planet toward and away from Earth. These apparent changes in a star's light as the star moves are due to a phenomenon known as the *Doppler effect.* The changes not only show that a planet is present but also indicate how much mass it has.

The amount of light coming from the star decreases when the planet passes in front of the star. The planet blocks some of the starlight, dimming the star.

The first discoveries. Astronomers announced the discovery of the first planets around a star other than our sun in 1992. The star is a pulsar named PSR B1257+12 in the constellation Virgo. *Pulsars* are dead stars that have collapsed until they are only about 12 miles (20 kilometers) across. They spin rapidly on their axes, sending out radio waves that arrive on Earth as pulses of radio energy. Some pulsars spin hundreds of times each second. If a pulsar has a planet, the planet pulls the star to and fro slightly as it orbits. These pulls cause slight variations in the radio pulses. From measurements of these variations, the Polish-born American astronomer Alexander Wolszczan and American Dale A Frail discovered three planets in orbit around PSR B1257+12. The star emits such strong X rays, however, that no life could survive on its planets.

Astronomers using the spectroscopic technique soo began to find planets around stars more like the sun. In 1995, Swiss astronomers Michel Mayor and Didier Queloz found the first planet orbiting a sunlike star, 51 Pegasi, in the constellation Pegasus. American astronomers Geoffrey W. Marcy and R. Paul Butler confirmed the discovery and found planets of their own around other stars. In 1999, astronomers announced the first discovery of a multiple-planet system belonging to a sunlike star. They determined that three planets orbit th star Upsilon Andromedae, which is 44 light-years from Earth in the constellation Andromeda.

Also in 1999, American astronomer Gregory W. Henr first detected a dimming of starlight due to the presenc of a planet. The star that Henry observed is known as H 209458, and it is located in Pegasus. Henry measured th star's brightness at the request of Marcy, Butler, and American astronomer Steven S. Vogt, who had previously used the spectroscopic technique to identify this star as a parent of a planet.

Some stars have a planet orbiting them at a distance

The planets at a glance*

	Mercury ☿	Venus ♀	Earth ⊕	Mars ♂
Average distance from the sun	35,980,000 mi (57,900,000 km)	67,230,000 mi (108,200,000 km)	92,960,000 mi (149,600,000 km)	141,620,000 mi (227,920,000 km)
Closest approach to Earth	57,000,000 mi (91,700,000 km)	25,700,000 mi (41,400,000 km)	————————	33,900,000 mi (54,500,000 km)
Length of year (earthdays)	87.97	224.7	365.26	686.98
Average orbital speed	29.76 mi per sec. (47.89 km per sec.)	21.77 mi per sec. (35.03 km per sec.)	18.51 mi per sec. (29.79 km per sec.)	14.99 mi per sec (24.13 km per se
Diameter at equator	3,031 mi (4,878 km)	7,521 mi (12,104 km)	7,926 mi (12,756 km)	4,222 mi (6,794 km)
Rotation period	59 earthdays	243 earthdays	23 hrs. 56 min.	24 hrs. 37 min.
Tilt of axis (degrees)	about 0	178	23.44	25.19
Temperature	−280 to +800 °F (−170 to +430 °C)	+860 °F (+460 °C)	−130 to +140 °F (−90 to +60 °C)	−195 to +70 °F (−125 to +20 °C
Mass (Earth = 1)	0.056	0.815	1	0.107
Density (g/cm^3)	5.42	5.25	5.52	3.93
Gravity (Earth = 1)	0.386	0.879	1	0.38
Number of known satellites	0	0	1	2

*Many of these figures are approximations or obtained by scientific calculations.

which living things could exist. Most scientists consid- liquid water essential for life, so a region that is nei- er too hot nor too cold for liquid water is known as a *ıbitable zone.* Although astronomers have found stars ith planets in their habitable zones, all the planets und so far are probably gaseous with no solid surface. ıt they may have solid moons.

In 2001, Marcy announced the discovery of a solar stem containing an extremely unusual object. That ob- ct and an ordinary planet orbit the star HD 168443, hich is 123 light-years away in the constellation Ser- ens. The object is so unusual because of its mass. It is least 17 times as massive as Jupiter.

Astronomers are not yet sure how to classify the ob- ct. They had not thought that a planet could be as mas- ve as the object is. Before this discovery, the only ıown heavenly bodies of such mass were dim objects lled *brown dwarfs.* But brown dwarfs form by means the same process that forms stars, not planets.

Astronomers were surprised to find that other solar stems have huge, gaseous planets in close orbits. In ır own solar system, the inner planets are rocky and nall, and only the outer planets, except for Pluto, are ıge and gassy. But several newly discovered planets ıve at least as much mass as Jupiter, the largest planet our solar system. Unlike Jupiter, however, these mas- ve planets race around their stars in only a few weeks. epler's third law says that for a planet to complete its bit so quickly, it must be close to its parent star. Sever- of these giant planets, therefore, must travel around eir stars even closer than our innermost planet, Mer- ıry, orbits our sun. Such close orbits would make their ırfaces too hot to support life as we know it.

Some newly discovered planets follow unusual orbits. ıost planets travel around their stars on nearly circular ıths, as the planets in our solar system do. But a planet ound the star 16 Cygni B follows an extremely elliptical bit. It travels farther from its star than Mars does from our sun, and then draws closer to the star than Venus does to our sun. If a planet in our solar system traveled in such an extreme oval, its gravity would disrupt the orbits of the other planets and toss them out of their paths.

How the planets formed

Astronomers have developed a theory about how our solar system formed that explains why it has small, rocky planets close to the sun and big, gaseous ones farther away. Astronomers believe our solar system formed about 4.6 billion years ago from a giant, rotating cloud of gas and dust called the *solar nebula.* Gravity pulled together a portion of gas and dust at the center of the nebula that was denser than the rest. The material accumulated into a dense, spinning clump that eventually formed our sun.

The remaining gas and dust flattened into a disk called a *protoplanetary disk* swirling around the sun. Protoplanetary disks around distant stars were first observed through telescopes in 1983. Rocky particles within the disk collided and stuck together, forming bodies called *planetesimals.* Planetesimals later combined to form the planets. At the distances of the outer planets, gases froze into ice, creating huge balls of frozen gas that formed the Jovian planets.

Hot gases and electrically charged particles flow from our sun constantly, forming a stream called the *solar wind.* The solar wind was stronger at first than it is today. The early solar wind drove the light elements—hydrogen and helium—away from the inner planets like Earth. But the stronger gravity of the giant outer planets held on to more of the planets' hydrogen and helium, and the solar wind was weaker there. So these outer planets kept most of their light elements and wound up with much more mass than Earth.

Astronomers developed these theories when they thought that rocky planets always orbited close to the parent star and giant planets orbited farther away from

ıpiter ♃	Saturn ♄	Uranus ♅	Neptune ♆	Pluto ♇
3,600,000 mi 78,300,000 km)	888,200,000 mi (1,429,400,000 km)	1,786,400,000 mi (2,875,000,000 km)	2,798,800,000 mi (4,504,300,000 km)	3,666,200,000 mi (5,900,100,000 km)
0,700,000 mi 28,760,000 km)	762,700,000 mi (1,277,400,000 km)	1,607,000,000 mi (2,587,000,000 km)	2,680,000,000 mi (4,310,000,000 km)	2,670,000,000 mi (4,290,000,000 km)
332.7 12 mi per sec. 3.06 km per sec.)	10,759 5.99 mi per sec. (9.64 km per sec.)	30,685 4.23 mi per sec. (6.81 km per sec.)	60,190 3.37 mi per sec. (5.43 km per sec.)	90,800 2.95 mi per sec. (4.74 km per sec.)
,846 mi 42,984 km)	74,898 mi (120,536 km)	31,763 mi (51,118 km)	30,800 mi (49,500 km)	1,430 mi (2,300 km)
hrs. 55 min. 08	10 hrs. 39 min. 26.73	17 hrs. 14 min. 97.92	16 hrs. 7 min. 28.80	6 earthdays 98.8
220 °F 140 °C)	−285 °F (−175 °C)	−360 °F (−220 °C)	−350 °F (−210 °C)	−390 to −370 °F (−230 to −220 °C)
7.892 33 53	95.184 0.69 1.07	14.54 1.27 0.91	17.15 1.64 1.14	0.0022 2.0 0.07
	30	20	8	1

it. But the "rule" was based only on our own solar system. Now that astronomers have learned something about other solar systems, they have devised new theories. Some scientists have suggested that the giant planets in other solar systems may have formed far from their parent stars and later moved in closer.

Jay M. Pasachoff

Related articles in *World Book* include:

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Outline

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- A. Orbits
- B. Rotation

III. **The planets of our solar system**
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- B. Venus
- C. Earth
- D. Mars
- E. Jupiter
- F. Saturn
- G. Uranus
- H. Neptune
- I. Pluto

IV. **Planets in other solar systems**
- A. How planets are detected
- B. The first discoveries

V. **How the planets formed**

Questions

Why is Venus called Earth's twin?
Which is the largest planet in our solar system? The smallest?
Why are planets in other solar systems difficult to see?
Who discovered the three laws of planetary motion?
What is an astronomical unit?
How do the four planets nearest the sun differ from the next four planets?
Why is Pluto not always the farthest planet from the sun?
How do astronomers believe our solar system formed?
How can you tell planets and stars apart in the night sky?
Which three planets have rings?

Additional resources

Level I

Dickinson, Terence. *Other Worlds: A Beginner's Guide to Planets and Moons.* Firefly Bks., 1995.

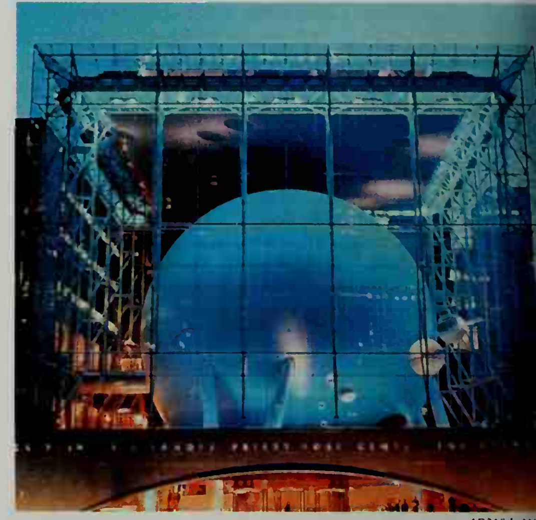
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Level II

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AP/Wide Wo

The Rose Center for Earth and Space in New York City hous the huge hollow sphere that makes up the Hayden Planetarium.

Planetarium is an educational device that shows the locations and movements of planets and other objects in the universe. A room or building that houses such a device is also called a planetarium. Each year, about 90 million people visit such places throughout the world.

Early planetariums were either (1) movable pictures c the starry sky painted on the inside of a sphere or dom or (2) mechanical models of the solar system. A modern planetarium projects images of the sun, moon, planets, stars, and other objects onto the inside of a dome-shaped screen. Until the early 1980's, planetariums could project the night sky as seen only from Earth. Since then, many planetariums have used computers to *simulate* (represent) the view from other locations.

Early planetariums

One of the first planetariums with a movable paintinc of the starry sky was known as the Gottorp Globe. That device was made in the mid-1600's in what is now Germany. The main part of the planetarium was a hollow copper sphere 10.2 feet (3.1 meters) in diameter. Inside were a table and a curved bench for 12 people. Painted on the sphere's inner surface were pictures of the constellations. The stars were copper nailheads coated wit gold. Light from a central oil lamp made them shine. A copper globe representing Earth lay on the table.

The hollow sphere could rotate relative to the bench The sphere's axis of rotation was an imaginary line that extended from the poles of the copper globe to the sky in the painting. Thus, the sphere's rotation simulated th apparent motion of the stars as Earth rotates on its axis.

Beginning in the late 1600's, clockmakers in Europe built small model planetariums that simulated the motion of the planets around the sun. A ball at the center represented the sun. Extending from the center were rods that held smaller spheres representing the planets By cranking or winding up the model, a person could move its miniature planets around the sun. A system of gears made the planets move at fairly accurate speeds relative to one another. Some models also showed how



© Dennis Finnin, AMNH

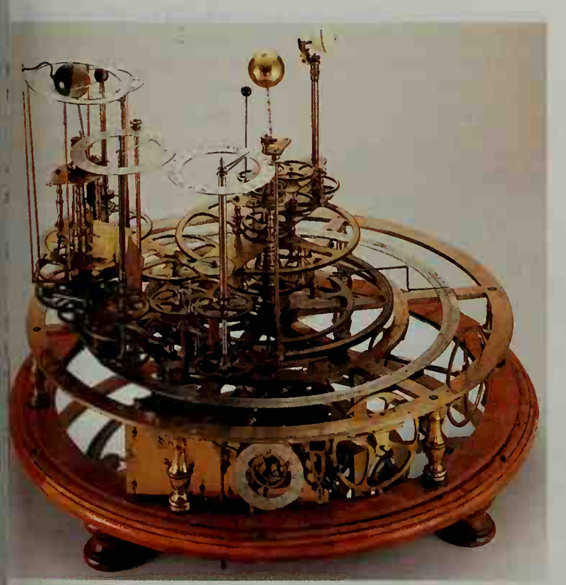
A projector at the Hayden Planetarium in New York City creates images of stars and a cloud of dust and gas on the planetarium dome. The projector can produce images of over 9,000 stars.

ıoons revolved around their planets.

Early in the 1700's, a model planetarium became ıown as an *orrery*—named for the Earl of Orrery, an ish nobleman who had one made in 1712. The manuıcture of small orreries continues to this day. Many scince teachers use them because they make the moveıents of the planets easy to understand.

The invention of electric lights and motors in the late 800's made it practical to build large orreries. The first of these was installed in the Deutsches Museum in Munich, Germany, in the early 1920's. At the center of a circular room was a large lighted globe that represented the sun. Smaller lighted globes represented the planets. The smaller globes were suspended from the ceiling by rods. The rods were attached to motor-driven cars that traveled along "orbital" tracks around the big globe.

Beneath the globe representing Earth was a small, motor-driven platform that an individual could ride. As the orrery ran, a rider could see a simulation of the planets' revolution around the sun from Earth's perspective. Similar versions of this kind of orrery were later built at the Hayden Planetarium in New York City and at the University of North Carolina at Chapel Hill.



© Adler Planetarium & Astronomy Museum

n orrery built in about 1780 used a complex system of gears to rive the planets of a model solar system in a way that imitated ıe revolution of the actual planets around the sun.

Modern planetariums

Mechanical projectors. In 1925, the German firm Carl Zeiss permanently installed the first modern planetarium at the Deutsches Museum in Munich. This device, called the Mark I, was mounted inside a dome 32 feet (10 meters) in diameter. People sat in chairs under the dome and looked up at images of stars, planets, the sun, and the moon.

A hollow metal sphere known as a *star ball* used 31 lenses to display images of 4,500 stars on the dome. The ball could rotate to simulate Earth's rotation. Seven additional projectors attached to the ball created images of the sun, the moon, Mercury, Venus, Mars, Jupiter, and Saturn. The seven projectors moved relative to the star ball, thereby simulating the motion of the planets relative to the stars.

The star ball was 20 inches (50 centimeters) in diameter. Light for the images came from a bright electric lamp in the center of the ball. The 31 lenses surrounded the lamp. Mounted behind each lens was a disk called a *star plate* that acted somewhat like a photographic slide.

Light from the lamp passed through holes in the plate. Each hole represented a star; bigger holes simulated brighter stars.

Each projector's lens focused onto the dome the light that passed through the holes in its star plate. Each plate represented a little more than 3 percent of the night sky. So, working together, the 31 projectors simulated nearly the entire sky.

The Munich planetarium could show how the stars would appear at any time of the night on any date from hundreds of years in the past to hundreds of years in the future. However, the planetarium was limited to views from Munich and other places that have the same northern latitude as that city. That is, the planetarium could show only stars that rose above the horizon at the latitude of Munich.

But improved versions of the Munich planetarium could simulate the sky as seen from any place on Earth and at any time up to 26,000 years into the past or future. The improved planetariums used two large star balls with the planet projectors in between.

The stars look the same from any place in the solar system—though the planets do not. Thus, the planetariums' simulations represented views of the stars as seen from any place in the solar system. The stars look the same because the solar system is much smaller than the distances to the stars. The average radius of the widest planetary orbit—the orbit of Pluto—is roughly $3 \frac{2}{3}$ billion miles (5.9 billion kilometers). The distance to the nearest star, Proxima Centauri, is about 25 trillion miles (40 trillion kilometers).

The success of the Zeiss projectors led to the establishment of thousands of planetariums in the 1900's. In the 1930's, the first Zeiss projectors were installed in the United States—at the Adler Planetarium in Chicago, the Hayden Planetarium in New York City, the Fels Planetarium at the Franklin Institute in Philadelphia, and the Griffith Observatory in Los Angeles. During the late 1900's, the Japanese firms Goto Optical Manufacturing Company and Minolta Company Limited and the U.S. company Spitz Incorporated also became leading makers of planetarium projectors.

The most advanced mechanical projectors can create images as sharp and as precise in color as the actual stars seen from a high mountain. One such device, a Zeiss Mark IX at the Hayden Planetarium in the Rose Center for Earth and Space in New York City, can project images of more than 9,000 stars. The projector has 32 star plates. Light for each star travels from a central lamp through an *optical fiber,* a hair-thin strand of glass. Because the fiber is so tiny, the image on the dome is pointlike—just like a real star in the sky. Separate projectors steered by computer-controlled motors create images of the sun, the moon, and planets.

Digital projectors. Even the best mechanical projectors can show the stars as seen from only one region of space—our solar system. The projectors have this limitation because the holes in their star plates cannot change position relative to one another.

However, a digital projector system does not use star plates, and so it does not have this limitation. Instead, a computer creates images on video screens. A lens then projects each image onto the dome. To show the stars as seen from a place other than the solar system, the computer merely changes the images on the screens. A planetarium with computerized projectors is known as a *digital planetarium* because computers use a code of numbers, or *digits,* to process information.

In the early 1980's, the Evans and Sutherland Corporation of the United States installed the first digital planetarium in the Science Museum in Richmond, Virginia. A computer created a single video image of the starry sky. A single large lens then projected this image onto the planetarium dome.

By the mid-1990's, digital planetariums produced by Evans and Sutherland and other companies brought new realism to images of planets. These advanced planetariums can create close-up views of a rotating planet.





The Gottorp Globe, built in the mid-1600's, was a hollow sphere with a bench for viewers. The bench stood still while a painting of the starry sky rotated, imitating the apparent nightly movement of the stars.

addition, they can simulate the view from a space pbe flying over a planet's surface. And they can even ow images of objects that are important in fields other tn astronomy. For instance, digital planetariums can nulate a "flight" through a tremendously magnified iage of a living cell.

In addition, digital planetariums can present shows f pure entertainment. One example of such a show is a play of animated, computer-generated art, accompaed by a musical sound track.

A digital planetarium at the Hayden Planetarium uses ven video projectors together to create a single ime. The computer is similar to machines used by *flight nulators,* devices that imitate an airplane in flight.

Even an ordinary desktop or laptop computer that is nning certain astronomy software can be thought of a digital planetarium. Computer programs available CD-ROM's can simulate sky conditions for any date d time. Many such programs contain photographs d motion pictures of astronomical objects. Such imes are also available on the Internet.

Portable planetariums. Many school systems and mmunities purchase inexpensive portable planetarins. One model has an inflatable dome that is designed hold 35 children. The projector consists of a small ht bulb surrounded by a plastic cylinder. Many cylinrs are available. For projecting the stars, there is a ack cylinder with clear spots for the stars. Other cylinrs show galaxies, constellations, and even the inside a living cell. James S. Sweitzer

lankton is the mass of tiny organisms that drifts at or ar the surface of oceans, lakes, and other bodies of ater. The word *plankton* comes from a Greek word at means *wandering.* Some planktonic organisms can vim, but they cannot swim strongly enough to avoid eing carried about by water currents.

A wide variety of organisms make up plankton. Many nnot be seen without a microscope. Scientists often vide plankton into two main types based on the organms it contains. These types are *phytoplankton* and *zoolankton.* Phytoplankton consists chiefly of simple, oneelled algae. Zooplankton includes microscopic rotozoans and such sea animals as copepods, water eas, and jellyfish.

Some organisms spend their entire life as plankton. hey are called *holoplankton.* Other organisms, called *eroplankton,* spend only part of their life as plankton. he most common meroplanktonic organisms are the ggs and *larvae* (immature forms) of animals that live on e floors of shallow oceans. These organisms drift eely as plankton until they develop into adults and sete to the bottom. Other meroplanktonic organisms inlude the eggs and larvae of larger, freely swimming annals, such as fish and squid.

Plankton plays an important part in *food webs* in bodes of water. Food webs are the feeding relationships etween organisms. Phytoplankton forms the base of ese food webs. Phytoplankton can grow using only unlight and the minerals in water in a process called *hotosynthesis.* Certain zooplankton eat phytoplankton. hese zooplankton are eaten by larger zooplankton and y fish and other water animals. Food material prouced by plankton also may sink and be consumed by ottom-dwelling organisms. David L. Garrison



W. H. Amos, Bruce Coleman Inc.

Plankton is made up of many types of organisms.

Related articles in *World Book* include:

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Pfiesteria
Red tide
Seashore

Planned Parenthood Federation of America is an organization concerned mainly with voluntary family planning and reproductive health care. The federation, often called Planned Parenthood or PPFA, seeks to ensure that people have access to birth control and to medically safe and legal abortions. Every year, millions of people receive medical care or information from PPFA clinics in about 1,000 communities throughout the United States. PPFA is a member of the International Planned Parenthood Federation and supports family planning projects in many other countries.

Services. PPFA clinics provide counseling and information on birth control and related health issues. They supply birth control devices and related medical services. PPFA clinics promote early detection of cancers of the reproductive system, offer counseling and screening services for AIDS and other sexually transmitted diseases, and provide medical care for pregnant women. PPFA clinics also offer menopause counseling and related services. Some PPFA clinics perform abortions. The organization also provides infertility treatment for men and women and counseling on adoption procedures.

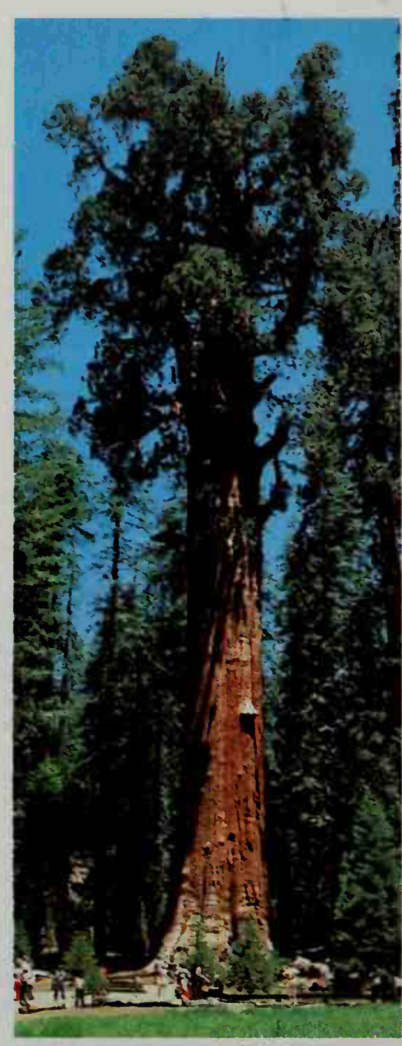
Funding for PPFA comes from private contributions, government grants, patient fees, and other payments for services. The organization's headquarters are in New York City.

History. Planned Parenthood traces its origins to 1916, when Margaret Sanger, an American nurse, opened the first birth control clinic in the United States. The clinic, in New York City, was closed under a state law that forbade the discussion of birth control. In 1921, Sanger founded the Birth Control League to promote family planning. The league became the Planned Parenthood Federation of America in 1942.

Many people support work done by Planned Parenthood. Corporations, foundations, and thousands of individuals contribute money annually. However, PPFA also faces opposition. Some groups criticize it for providing birth control information and services to adolescents. Some people object to PPFA's support of abortion.

Susan Lutz Wallace

See also **Birth control; Sanger, Margaret.**





© Breck Kent, Earth Scenes

A towering sequoia





© Frank Oberle, Bruce Coleman

Kernels harvested from corn plants



© L. West, Bruce Coleman

Moss plants growing on a rock

Plants vary greatly in size and form, ranging from tall, majestic trees to tiny, simple mosses. More than 260,000 species of plants grow in all parts of the world. Plants supply people with food and many other useful products. They also add beauty and pleasure to people's lives.

Plant

Plant. Plants grow in almost every part of the world. We see such plants as flowers, grass, and trees nearly every day. Plants also grow on mountaintops, in the oceans, and in many desert and polar regions.

Without plants, there could be no life on the earth. People could not live without air or food, and thus could not live without plants. The oxygen in the air we breathe comes from plants. Our food comes from plants or from animals that eat plants. We build houses and make many useful products from lumber. Much of our clothing is made from the fibers of the cotton plant.

Scientists believe there are over 260,000 *species* (kinds) of plants, but no one knows for sure. Some tiny plants that grow on the forest floor can barely be seen. Others tower over people and animals. Among the largest living things on the earth are the sequoia trees of California. Some stand over 290 feet (88 meters) high and measure over 30 feet (9 meters) wide. Plants also are the oldest living things. One bristlecone pine tree in California started growing 4,000 to 5,000 years ago.

Scientists divide all living things into five main groups called *kingdoms*. These kingdoms are (1) plants, (2) animals, (3) fungi, (4) protists, and (5) prokaryotes. Scientists classify organisms in a particular kingdom because

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© Zig Leszczynski, Earth Scenes

ɔotanical garden displaying a variety of trees and colorful flowers



© Robert Knowles, Photo Researchers

ındscaping in an office building



© Steve Kaufman, Peter Arnold, Inc.

Collecting sap from a maple tree

ıe organisms share certain basic characteristics. These haracteristics include physical structure, means of obıining food, and means of reproduction.

Plants have characteristics that set them apart from ther living things. For example, both plants and aniıals are complex organisms that are made up of many ypes of cells. But plant cells have thick walls that consist f a material called *cellulose.* Animal cells do not have ıis material. The cells of prokaryotes and some protists, ke those of plants, have cellulose walls. But prokaryotes and protists are simple organisms made up of one ell or only a few types of cells. Bacteria, including *yanobacteria* (blue-green algae), are prokaryotes. Prosts include other algae and diatoms and protozoans.

All plants develop from a tiny form of the plant called n *embryo.* Prokaryotes, protists, and fungi—such as molds and mushrooms—do not develop from embryos. Plants also obtain food in ways different from those of most other organisms. Almost all kinds of plants stay in one place for their entire lives. Most plants make their own food from air, sunlight, and water by a process called *photosynthesis.* Fungi cannot make their own food. They obtain the nutrients they need from the animals, plants, and decaying matter on which they live. Animals also cannot make their own food, but most animals can move about to find it.

This article provides general information on the plant kingdom. It tells why plants are important to people and describes the major groups of plants and where and how they live. It includes a classification table of the plant kingdom. See the *Related articles* at the end of this article for a list of articles on many kinds of plants.

The importance of plants

Plants supply people with food, clothing, and shelter. Many of our most useful medicines are also made from plants. In addition, plants add beauty and pleasure to our lives. Most people enjoy the smell of flowers, the sight of a field of waving grain, and the quiet within a forest.

Not all plants are helpful to people. Some species grow in fields and gardens as weeds that choke off useful plants. Tiny bits of pollen from certain plants cause such health problems as asthma and hay fever. Some plants are poisonous if eaten. Others, such as poison ivy and poison oak, irritate the skin.

Food. Plants are probably most important to people as food. Sometimes we eat plants themselves, as when we eat apples, peas, or potatoes. But even when we eat meat or drink milk, we are using foods that come from an animal that eats plants.

People get food from many kinds of plants—or parts of plants. The seeds of such plants as corn, rice, and wheat are the chief source of food in most parts of the world. We eat bread and many other products made from these grains, and almost all our meat comes from animals that eat them. When we eat beets, carrots, or sweet potatoes, we are eating the roots of plants. We eat the leaves of cabbage, lettuce, and spinach plants; the stems of asparagus and celery plants; and the flower buds of broccoli and cauliflower plants. The fruits of many plants also provide us with food. They include apples, bananas, berries, and oranges, as well as some nuts and vegetables. Coffee, tea, and many soft drinks get their flavor from plants.

Raw materials. Plants supply people with many important raw materials. Trees give us lumber for building homes and making furniture and other goods. Wood chips are used in manufacturing paper and paper products. Other products made from trees include cork, natural rubber, maple syrup, and turpentine. Most of the world's people wear clothing made from cotton. Threads of cotton are also woven into carpets and other goods. Rope and twine are made from hemp, jute, and sisal plants.

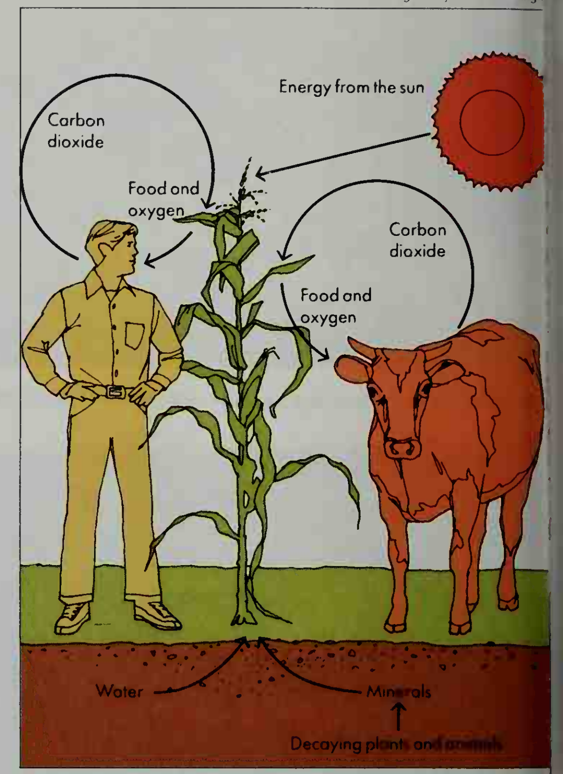
Plants also provide an important source of fuel. In many parts of the world, people burn wood to heat their homes or to cook their food. Other important sources of fuel—coal, oil, and natural gas—also come from plants. Coal began to form millions of years ago, when great forests and swamps covered much of the earth. As the trees in these forests died, they fell into the swamps, which were then covered by mud and sand. The increasing pressure of this mass of materials helped cause the dead plants to turn into coal. Petroleum and natural gas were formed in ancient oceans by the pressure of mud, sand, and water on decaying masses of plants and animals.

Medicines. Many useful drugs come from plants. Some of these plants have been used as medicines for hundreds of years. More than 400 years ago, for example, some Indian tribes of South America used the bark of the cinchona tree to reduce fever. The bark is still used to make *quinine,* a drug used to treat malaria and other diseases. Another drug, called *digitalis,* is used in treating heart disease. It is made from the dried leaves of the purple foxglove plant. The roots of the Mexican yam are used in producing *cortisone,* a drug useful in treating arthritis and a number of other diseases.

Plants and the cycle of nature

Plants play an important part in the cycle of nature. They grow by taking energy from the sun, carbon dioxide from the air, and water and minerals from the ground. During the cycle, plants supply us with food and give off the oxygen that we breathe.

WORLD BOOK diagram by David Cunningh



Plants and the cycle of nature. All living things—plants, animals, fungi, protists, and prokaryotes—are linked by the *cycle of nature.* This natural process gives people oxygen to breathe, food to eat, and heat to keep them warm. The sun supplies the energy that runs the cycle.

Plants have a complex relationship with people and animals in the cycle of nature. Plants use sunlight to make their own food, and they give off oxygen during the process. People and animals eat the plants and breathe in the oxygen. In turn, people and animals breathe out carbon dioxide. Plants combine the carbon dioxide with energy from sunlight and water and minerals from the soil to make more food. After plants and animals die, they begin to decay. The rotting process returns minerals to the soil, where plants can again use them.

Plants also play an important part in *conservation,* the protection of soil, water, wildlife, and other natural resources. Plants help keep the soil from being blown away by the wind or washed away by the water. They slow down the flow of water by storing it in their roots, stems, and leaves. Plants also give wild animals food to eat and a safe place to live. For more information on the importance of plants in nature, see the *World Book* articles on **Balance of nature, Conservation,** and **Ecology.**

Each of the more than 260,000 species of plants differs ɔm every other species in one or more ways. How- er, plants also have many features in common. Based ı these similarities, scientists are able to classify dis- ıct plants into groups. The study of plants is called *ɔtany,* and scientists who study plants are known as *ɔtanists.*

This section describes the chief kinds of plants found the plant kingdom. It is divided into five basic groups: seed plants, (2) ferns, (3) lycopsids, (4) horsetails, and bryophytes. A table showing a more detailed system plant classification that is used by many botanists ap- ɜars at the end of the article. See also **Classification, :ientific.**

Seed plants consist of a wide variety of plants that ɜar seeds to reproduce. Most botanists divide the seed ants into two main groups of plants—angiosperms *and* /mnosperms.

Angiosperms are flowering plants. They make up the ıst majority of the more than 260,000 kinds of plants. ıey produce seeds that are enclosed in a protective ɜed case. The word *angiosperm* comes from two reek words meaning *enclosed* and *seed.* All plants that roduce flowers and fruits are angiosperms. They in- ude most of our common plants, such as brightly colored garden plants, many kinds of wildflowers, and most trees, shrubs, and herbs. Most of the plants that produce the fruits, grains, and vegetables that people eat also are angiosperms. See **Angiosperm.**

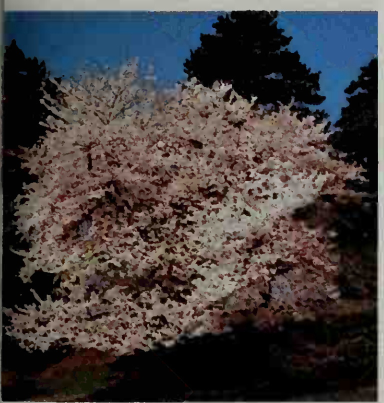
The sizes of angiosperms vary greatly. The smallest flowering plant, the duckweed, is only about $\frac{1}{50}$ inch (0.5 millimeter) long. It floats on the surface of ponds. The largest angiosperms are eucalyptus trees. They grow more than 300 feet (91 meters) tall.

Some botanists divide the angiosperms into two smaller groups. Plants in one group, called *monocotyledons* or *monocots,* grow from seeds that contain one seed leaf called a *cotyledon* (see **Cotyledon**). Plants in the other group, called *dicotyledons* or *dicots,* have two cotyledons in their seeds.

Gymnosperms include a wide variety of trees and shrubs that produce naked or uncovered seeds. Most gymnosperms bear their seeds in cones. The word *gymnosperm* comes from two Greek words meaning *naked* and *seed.* Gymnosperms do not produce flowers. This group is made up of such plants as conifers, cycads, ginkgoes, and gnetophytes. See **Gymnosperm.**

Conifers are the best known of the gymnosperms. They include such trees as cedars, cypresses, firs, pines, redwoods, and spruces. Most conifers have needlelike

ngiosperms Any plant that produces flowers and fruits is considered an angiosperm. The vast majority of all the many kinds of plants belong to this group.


A. W. Ambler, NAS
:herry tree


W. H. D. Wince, Bruce Coleman, Ltd.
Wood anemone


Jane Burton, Bruce Coleman, Ltd.
Grasses


Robert H. Glaze, Artstreet
:otton—buds, flowers, and bolls


Walter Dawn
Tomato—flowers and young fruits


A. W. Ambler, NAS
Prickly pear cactus

or scalelike leaves. Their seeds grow on the upper side of the scales that make up their cones. The cones of some conifers, such as junipers, look like berries. Most conifers are *evergreens*—that is, they shed old leaves and grow new leaves continuously and so stay green throughout the year. Wood from conifers is widely used in construction and papermaking. Conifers also provide animals with food and shelter. See **Conifer**.

Cycads and ginkgoes have lived on the earth for millions of years. Large numbers of these plants once grew over wide regions of land. Most cycads look much like palm trees. They have a branchless trunk topped by a crown of long leaves. But unlike palm trees, they bear their seeds in large cones. Only one kind of ginkgo survives today. It is an ornamental tree with flat, fan-shaped leaves. It bears seeds at the ends of short stalks along its branches. See **Cycad; Ginkgo**.

Gnetophytes are the gymnosperms most closely related to angiosperms. They have many features that resemble those of flowering plants. For example, *Gnetum* has broad, oval-shaped leaves and special water-transport tubes, much like those of angiosperms. The cones of all gnetophytes are flowerlike in many details.

Ferns grow chiefly in moist, wooded regions. They vary widely in size and form. Some aquatic ferns have leaves only about 1 inch (2.5 centimeters) long. But in th tropics, tree ferns may grow more than 65 feet (20 meters) high.

Fern leaves, called *fronds,* usually are made up of many tiny leaflets and may be quite large. On most typ of ferns, the fronds are the only parts that grow above the ground. They grow from underground stems that may run horizontally under the surface of the ground. When the fronds first appear, they are tightly coiled. Th fronds unwind as they grow.

During prehistoric times, great numbers of large ferns covered the earth. These ferns, along with giant club mosses and horsetails, accounted for much of the plant life that later formed coal. See **Fern**.

Lycopsids include club mosses, quillworts, and selaginellas. These plants have leaves with a single, centr vein. Lycopsids were among the first plants to grow on land.

Club mosses have tiny needlelike or scalelike leaves that usually grow in a spiral pattern. They are not true mosses. Club mosses are found from tropical to tempe ate regions. They often form a "carpet" on the forest floor. See **Club moss**.

Quillworts are found chiefly in moist soils around lakes and streams. They have short stems and long,

Gymnosperms Most of the trees and shrubs that make up this group bear their seeds in cones and have needlelike or scalelike leaves. The yew and ginkgo do not have seed cones.



Edward S. Ross

Douglas-fir

Grant Heilman

Engelmann spruce



© Patti Murray, Earth Scen

Cycad

Edward S. Ross

Mediterranean pine



C. E. Mohr, NAS

Japanese yew



© J. C. Carton, Bruce Coleman In

Ginkgo

F[illegible]ns and horsetails

These plants grow chiefly in moist, wooded areas. Fern leaves, called *fronds,* often consist of many small leaflets and may be quite large. Horsetails have tiny leaves and hollow, jointed stems.



Hoppock Associates

[illegible]w York fern



Walter Chandoha

Tree fern



© E. R. Degginger

Horsetail

[illegible]copsids

These plants include club mosses, quillworts, and selaginellas. Club mosses have tiny needlelike or scalelike leaves. Quillwort leaves are long and grasslike. Selaginellas have small, thin leaves.



Edward S. Ross

[illegible]ound pine club moss



R. C. Simpson, Tom Stack & Associates

Quillwort



© W. H. Hodge, Peter Arnold, Inc.

Selaginella

[illegible]yophytes

Liverworts, mosses, and hornworts make up this group. These small plants grow in most parts of the world. They thrive in moist, shady places, such as ravines and forests.



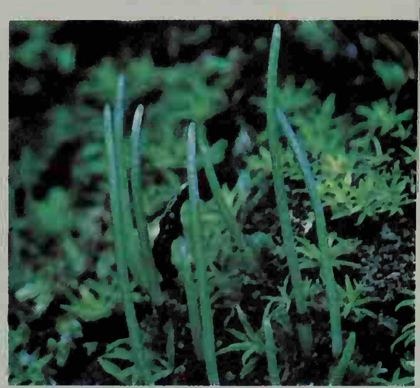
© John Shaw, Tom Stack & Associates

[illegible]verwort



Walter Chandoha

Sphagnum moss



© Ken Davis, Tom Stack & Associates

Hornwort

grasslike leaves. The leaves usually grow to about 14 inches (36 centimeters) long. Ancient plants related to quillworts were large trees that grew up to 120 feet (37 meters) tall. These plants lived about 290 million years ago.

There are about 700 kinds of selaginellas. These plants are usually found in tropical and subtropical regions. They often grow in damp places on the forest floor. Selaginellas have small, thin leaves. Their stems may either grow upright or along the ground. These plants first appeared on earth over 300 million years ago.

Horsetails are a group of small plants that have hollow, jointed stems. Horsetails grow about 2 to 3 feet (60 to 90 centimeters) tall. The plants have green stems and tiny, black leaves. The stems capture the sunlight used by the plant to make food in photosynthesis. In some horsetails, the branches grow in *whorls* (circles) around the main stem of the plant, and the plant resembles a horse's tail. Tiny amounts of minerals are concentrated in the stems of horsetails, including gold and silica. Silica makes the stems very coarse, like sandpaper. Som kinds of horsetails are called *scouring rush* because people once used these plants to scour their pots and pans. See **Horsetail.**

Bryophytes are a group made up of liverworts, mosses, and hornworts. These plants live in almost all parts of the world, from the Arctic to tropical forests. They grow in such moist, shady places as forests and ravines. Bryophytes are the only types of plants that lac *vascular tissue*—that is, tissue that carries water and food throughout the plant.

Most liverworts, mosses, and hornworts measure le than 8 inches (20 centimeters) tall. None of these plants have true roots. Instead, they have hairy rootlike growths called *rhizoids* that anchor the plants to the so and absorb water and minerals.

Peat moss, a substance made up of thick growths of *Sphagnum* and other mosses, is often used in gardening. Gardeners mix peat moss into the soil to keep the soil loose and to help it hold moisture. See **Hornwort; Liverwort; Moss.**

Where plants live

Most species of plants live in places that have warm temperatures at least part of the year, plentiful rainfall, and rich soil. But plants can live under extreme conditions. Mosses have been found in Antarctic areas where the temperature seldom rises above 32 °F (0 °C). Many desert plants grow in areas where the temperature may rise well above 100 °F (38 °C).

Not all kinds of plants grow in all parts of the world. For example, cattails live only in such damp places as swamps and marshes. Cactuses, on the other hand, are found chiefly in deserts. Through long periods of time, many small changes have taken place in various kinds of plants. These changes have enabled the plants to survive in a particular environment. For a discussion of some of these changes, see the section of this article *How plants change.*

Many elements make up a plant's environment. One of the most important is the weather—sunlight, temperature, and *precipitation* (rain, melted snow, and other moisture). The environment of a plant also includes the soil and the other plants and the animals that live in the same area. All these elements form what scientists call a *natural community.*

No two natural communities are exactly alike, but many resemble one another more than they differ. Botanists divide the world into *biomes*—natural communities of plants, animals, and other organisms. Important land biomes include (1) the tundra, (2) forests, (3) chaparrals, (4) grasslands, (5) savannas, and (6) deserts. Forests are often subdivided into smaller biomes, such as temperate deciduous forests and tropical rain forests. In addition, many plants live in *aquatic* (water) regions that are not grouped as a specific biome. See **Biome.**

Human beings have greatly affected the natural communities. In North America, for example, great forests once extended from the Atlantic Ocean to the Mississippi River. Most of the trees were cleared by advancing settlers, and the forests have been replaced by cities and farms. In other parts of the world, irrigation and the use of fertilizers have enabled plants to be grown on once-barren land.

This section describes the natural plant life in the im portant land biomes and in aquatic regions. For inform tion on where animals live, see the **Animal** article. For discussion of the relationship between living things an their environment, see **Ecology.**

The tundra is a cold, treeless area that surrounds th Arctic Ocean, near the North Pole. It extends across the uppermost parts of North America, Europe, and Asia. The land in these regions is frozen most of the year, an the annual precipitation measures only from 6 to 10 inches (15 to 25 centimeters). The upper slopes of the world's highest mountains—the Alps, the Andes, the Himalaya, and the Rockies—have conditions similar to those in the tundra.

Summers in the tundra last only about 60 days, and summer temperatures average only about 45 °F (7 °C). The top 1 foot (30 centimeters) or so of the land thaws during the summer, leaving many marshes, ponds, and swamps. Such plants as mosses, shrubs, and wildflowers grow in the tundra. These plants grow in low clump and so are protected from the wind and cold. A thick growth of *lichens* (organisms made up of algae and fungi) covers much of the land. See **Tundra.**

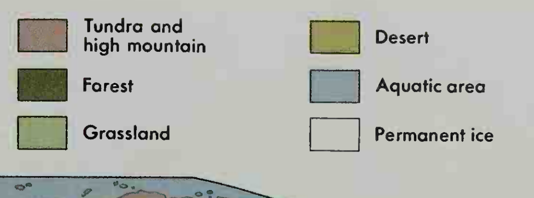
Forests cover almost a third of the earth's land area. They consist chiefly of trees, but many other kinds of plants also grow in forests. Some botanists divide the many types of forests into three major groups: (1) coniferous forests, (2) temperate deciduous forests, and (3) tropical rain forests.

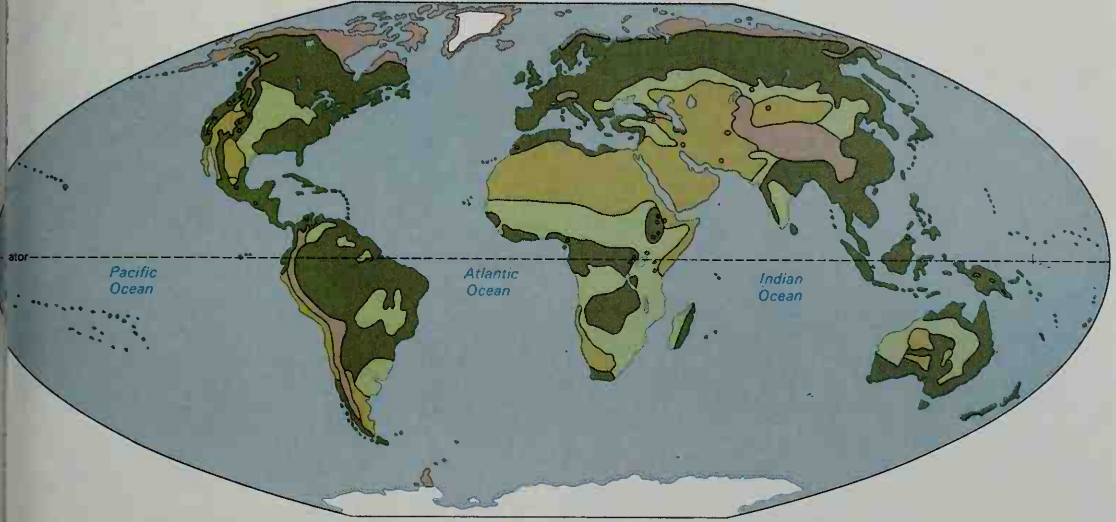
Coniferous forests are made up mainly of trees that are *coniferous* (cone-bearing) and evergreen. Most eco ogists distinguish between *boreal forests,* also called *taiga,* and *temperate coniferous forests.*

Boreal forests grow in regions that have a short summer and a long, cold winter. The growing season in these regions may last less than three months. Boreal forests are found in the northernmost parts of North

jor plant regions of the world

its live everywhere except in regions that have permanent
But not all plants grow in all regions of the world. This map
ws the five major regions in which certain kinds of plants
w best. For example, cacti grow chiefly in deserts, and cat-
in *aquatic* (watery) regions.





Adapted from *Physical Elements of Geography,* Fifth Edition, by Trewartha, Robinson, & Hammond. Copyright © 1967 by McGraw-Hill, Inc. Used by permission of McGraw-Hill Book Company.

erica, Europe, and Asia. They also grow in the high
untains of these continents. Trees found in boreal
ests include such evergreen conifers as balsam firs,
ck spruces, jack pines, and white spruces. The
nty, triangular shape of these trees helps them shed
vy snow.

ew plants grow on the floor of boreal forests. Thick
ers of old needles build up beneath the trees. These
edles contain acids that are slowly released as the
edles decay. Water carries the acids into the soil. The
dic water dissolves many minerals and carries them
the deeper layers of the soil. As a result, the topsoil
nd in boreal forests is often very sandy and unable to
port many types of small plants.

Temperate coniferous forests grow in western North
erica in areas that have mild, wet winters and dry
nmers. The redwood forests of northern California
l the temperate rain forests found on the Olympic
insula of Washington are both examples of temper-
coniferous forests. Major trees of the temperate co-
erous forest include redwoods and giant sequoias in
south and Douglas-firs, hemlocks, cedars, and pines
nore northern areas.

emperate deciduous forests cover large areas of
rth America, central Europe, east Asia, and Australia.
he United States, temperate deciduous forests grow
stly east of the Mississippi River and extend north-
rd into the Northern States and southern Canada,
ere they become mixed with coniferous forests. Most
hese areas have cold winters and warm, wet sum-
rs.

Most of the trees in temperate deciduous forests are
ed *broadleaf trees* because they have broad, flat
ves. They also are *deciduous*—that is, they lose their
ves every fall and grow new ones in the spring. Trees
that grow in temperate deciduous forests include bass-
woods, beeches, birches, hickories, maples, oaks, pop-
lars, tulips, and walnuts. A thick growth of wild flowers,
seedlings, and shrubs covers the floor of most of these
forests.

Tropical rain forests grow in regions that have warm, wet weather the year around. These regions include Central America and the northern parts of South America, central and western Africa, Southeast Asia, and the Pacific Islands.

Most trees in tropical rain forests are broadleaf trees. Because of the warm, wet weather, they never completely lose their leaves. These trees lose a few leaves at a time throughout the year. Many kinds of trees grow in tropical rain forests, including mahoganies and teaks. The trees grow so close together that little sunlight can reach the ground. As a result, only ferns and other plants that require little sunlight can grow on the forest floor. Many plants, including lichens, orchids, and vines, grow high on the trees.

The heavy rainfall that occurs in tropical rain forests dissolves much of the nutrients and organic materials out of the soil. As a result, the soils found in tropical rain forests contain a very small amount of nutrients and organic matter. However, the soil is able to support the lush growth found in these forests because fresh nutrients from the decay of fallen leaves are continually being released into the soil.

Chaparrals consist of thick growths of shrubs and small trees. Cork and scrub oaks, manzanitas, and many unusual herbs are often found on chaparrals. Chaparrals occur in areas that have hot, dry summers and cool, wet winters. Such areas are found in the western part of North America, the southern regions of Europe near the Mediterranean Sea, the Middle East, northern Africa,

WORLD BOOK illustration by Alex

Plants of the high mountain tundra

Many kinds of mosses, shrubs, and wild flowers survive the long, cold winters of the high mountain tundra. Farther down the mountains, conifers begin to appear.

1. Alpine fir
2. Bristlecone pine
3. Englemann spruce
4. Moss campion
5. Sedum
6. Alpine forget-me-not
7. Sheep laurel
8. White phlox
9. Squawfeather
10. Saxifrage
11. Mountain avens



WORLD BOOK illustration by John F. Eg

Plants of the coniferous forest

Towering trees, such as hemlocks, cedars, and Douglas-firs, dominate the temperate coniferous forest on the Olympic Peninsula of Washington. Many small plants grow on the forest floor.

1. Western redcedar
2. Western sword fern
3. Sitka spruce
4. Horsetail
5. Douglas-fir
6. Wood sorrel
7. Piper bellflower
8. Western hemlock

d the southern parts of South America, Africa, and stralia.

During the dry summer season, fires are common on aparrals. But these fires actually help to maintain the nt life. Many of the plants that grow on chaparrals are her resistant to fire or are able to grow back quickly er they burn. The fires clear the dense vegetation ay and expose bare ground to allow for new growth. e heat of the fires also stimulates development in the eds of some plants. In addition, many types of short-ed, small flowers appear only after a fire has taken ce. See **Chaparral**.

Grasslands are open areas where grasses are the st plentiful plants. In the United States and Canada, st of the natural grasslands are used to grow crops. ere, farmers and ranchers grow such grains as barley, ts, and wheat where bluestem, buffalo, and grama sses once covered the land.

Botanists divide grasslands into *steppes* and *prairies.* ly short grasses grow on steppes. These dry areas in-de the Great Plains of the United States and Canada, *veld* of South Africa, and the plains of Kazakhstan d southern Russia. Taller grasses grow on the prairies the American Midwest, eastern Argentina, and parts Europe and Asia. Rolling hills, clumps of trees, and ers and streams break up these areas. Most of the soil ich and rainfall is plentiful. As a result, prairie land is ed almost entirely to raise food crops and livestock. e **Grassland**.

Savannas are grasslands with widely spaced trees. me savannas are found in regions that receive little n. Others are found in tropical regions, such as the mos of Venezuela, the Campos of southern Brazil, d the Sudan of Africa. Most of these areas have dry nters and wet summers. Grasses grow tall and stiff der such conditions. Acacia, baobab, and palm trees ow on many savannas. A wide variety of animals, such antelope, giraffes, lions, and zebras, roam the savan-s of Africa. See **Savanna**.

Deserts cover about a fifth of the earth's land. A huge sert region extends across northern Africa and into ntral Asia. This region includes three of the world's eat deserts—the Arabian, the Gobi, and the Sahara. her major desert regions of the world include the cama Desert along the western coast of South Amer-, the Kalahari Desert in southern Africa, the Western teau of Australia, and the southwest corner of North erica.

Some deserts have almost no plant life at all. Parts of Gobi and the Sahara, for example, consist chiefly of fting sand dunes. All deserts receive little rain and e either rocky or sandy soil. The temperature in most serts rises above 100 °F (38 °C) for at least part of the r. Some deserts also have cold periods. But in spite hese harsh conditions, many plants live in desert re-ns. These plants—sometimes called *xerophytes*—in-de acacias, cactuses, creosote bushes, Joshua trees, ebrush, and yuccas. wildflowers are also found in desert. See **Flower** (Flowers of the desert [with tures]).

Desert plants do not grow close together. By being ead out, each plant can get water and minerals from rge area. The roots of most desert plants extend over ge areas of land, and they capture as much rain

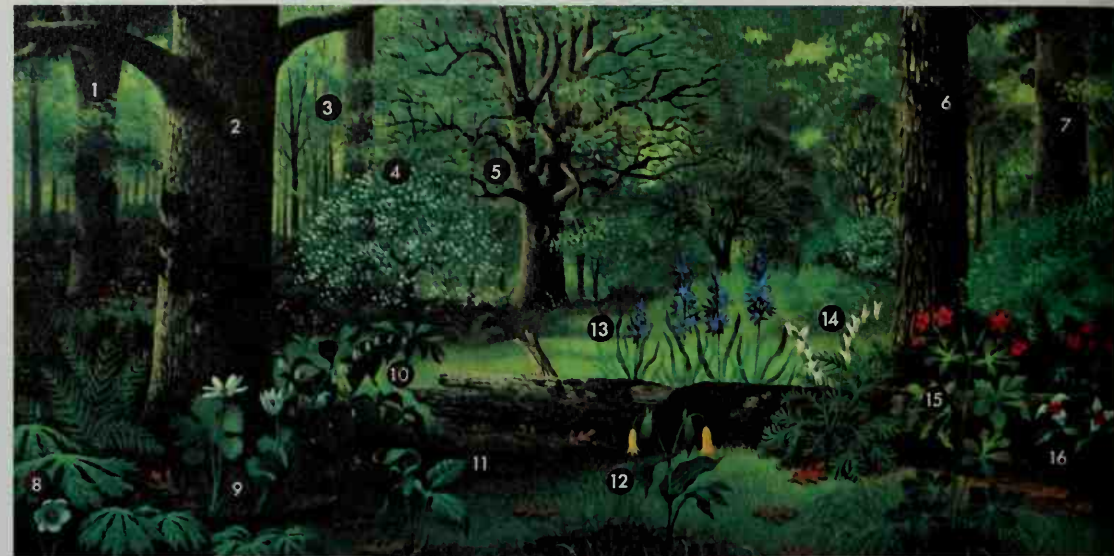


WORLD BOOK illustration by Lowell Hess

Plants of the tropical rain forest

Trees grow close together in this African rain forest, and vines climb high on the trees. Most of these plants are listed by their scientific names, though all have local common names.

1. *Lophira procera*
2. *Scottellia kamerunensis*
3. *Casearia bridelioides*
4. *Pausinystalia*
5. *Strombosia pustulata*
6. *Picralima umbellata*
7. *Diospyros insculpta*
8. Lianas
9. Strangler fig
10. *Ako ombe*



WORLD BOOK illustration by Lowell H

Plants of the temperate deciduous forest

Trees are the chief plants in a temperate deciduous forest. Most of them lose their leaves every winter. In spring, before the new leaves are fully grown, wild flowers bloom on the forest floor.

1. American elm
2. White oak
3. Mockernut hickory
4. Dogwood
5. Black oak
6. Shagbark hickory
7. Tulip tree
8. May apple
9. Bloodroot
10. Solomon's-seal
11. Jack-in-the-pulpit
12. Bellwort
13. Wild hyacinth
14. Dutchman's-breeches
15. Wild geranium
16. Painted trillium



WORLD BOOK illustration by John F. Eg

Plants of the chaparral

Thick growths of shrubs and small trees flourish in the hot, dry summers and cool, wet winters of the chaparral. Fires frequently occur during the summer and help stimulate new plant growth.

1. Sugarbush
2. California buckwheat
3. White sage
4. Chamise
5. Black sage
6. Coyote brush
7. California scrub oak
8. Deerweed



WORLD BOOK illustration by Alex Ebel

nts of the grasslands

d grasses, such as big bluestem and prairie cordgrass, once covered the Great Plains of the
ted States and Canada. Most of these grasslands are now used for crops or for grazing.

1 idian grass
2 witchgrass
3. Prairie cordgrass
4. Canada wild rye
5. Big bluestem

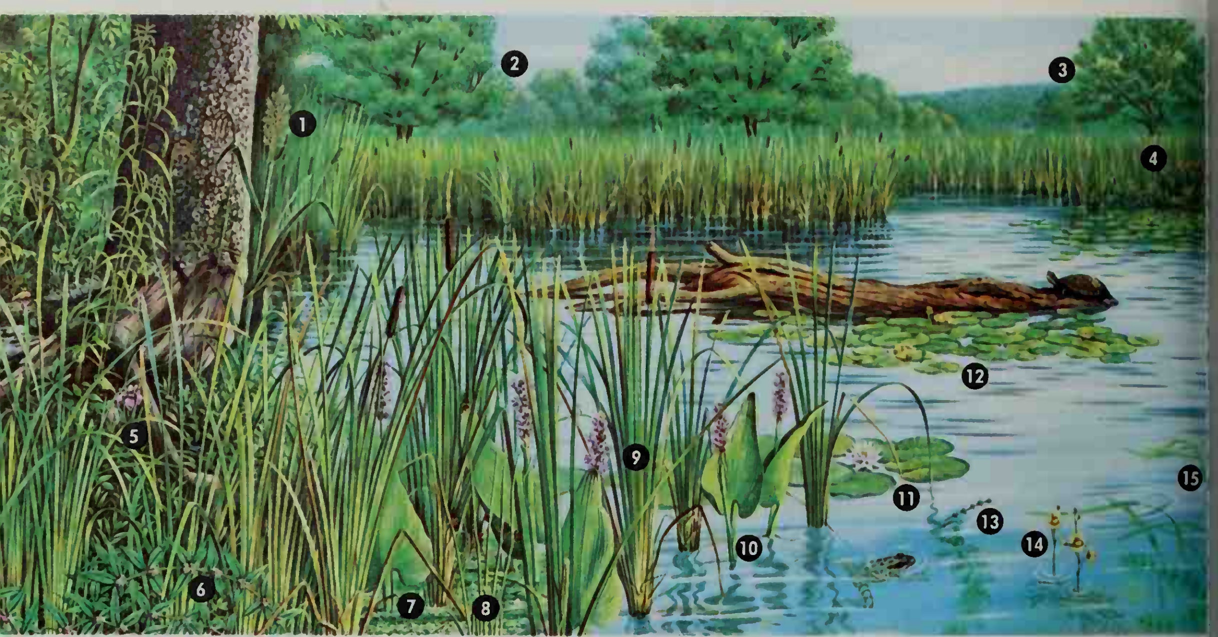


WORLD BOOK illustration by Lowell Hess

nts of the desert

ny kinds of cactus plants grow in the desert areas of the American Southwest. Like all desert
its, these cactuses can survive long dry periods and very hot temperatures.

1 mping cholla
2 lesquite
3 mping cholla
4. Barrel cactus
5. Saguaro
6. Bur sage
7. Organ-pipe cactus
8. Ocotillo
9. Paloverde
10. Prickly pear
11. Desert marigold
12. Brittlebush
13. Strawberry hedgehog



WORLD BOOK illustration by Alex

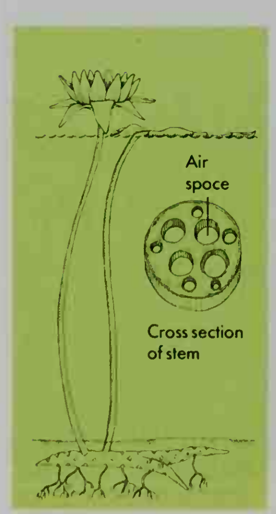
Plants of a freshwater pond

Many species of plants grow in and around ponds and other bodies of fresh water. Some of these plants live completely underwater, but others grow partly in and partly out of the water.

1. Reed grass	5. Blue flag	9. Cattail	13. Water milfoil
2. Black willow	6. Swamp-loosestrife	10. Pickerelweed	14. Bladderwort
3. Silver maple	7. Sphagnum moss	11. White water lily	15. Wild celery
4. Purple loosestrife	8. Sedge	12. Yellow water lily	

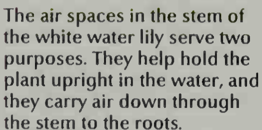
Special features of freshwater plants

Plants that live in ponds have special features that enable them to survive. The features of two kinds of these plants, the white water lily and a water milfoil, are shown below.





WORLD BOOK illustrations by Margaret Ann Moran


The air spaces in the stem of the white water lily serve two purposes. They help hold the plant upright in the water, and they carry air down through the stem to the roots.

The long, underwater leaves of the water milfoil are especially suited to absorb carbon dioxide from the water. The leaves that grow above water resemble those of land plants.

water as possible. Cactuses and other *succulent* (juicy plants store water in their thick leaves and stems. See **Cactus; Desert.**

Aquatic regions are bodies of fresh or salt water. Freshwater areas include lakes, rivers, swamps, and marshes. Coastal marshes and oceans are saltwater re gions. Most aquatic plants, which are also called *hydr phytes,* live in places that receive sunlight. These plant grow near the water surface, in shallow water, or alon the shore.

Some kinds of aquatic plants, including eelgrass, liv completely under the surface of the water. Other species of aquatic plants, such as duckweed, the smallest known flowering plant, float freely on the surface. Still others, such as the water marigold, grow only partly u derwater. Many aquatic plants have air spaces in their stems and leaves. The air spaces help them stand erec or stay afloat.

Aquatic regions have unique conditions that make i difficult for many types of plants to grow there. For example, swamps and marshes, as well as flood plains along many streams and rivers, become flooded leavi the plants that live in these areas completely covered l water. As a result, only a few species of plants are able to survive in aquatic regions. Common freshwater pla include duckweeds, pondweeds, water lilies, sedges, and cattails. Such trees as baldcypresses, blackgums, and willows also grow in fresh water. Saltwater plants include eelgrass, cordgrass, and many types of sedge See **Water plant.**

ıll plants—like all living things—are made up of cells. Ir lants, there are many kinds of cells that have special jcs, and together these cells form the various parts of th plant. A giant redwood tree, for example, has many b ons of cells. See **Cell.**

group of cells that are organized to perform a parti lar function is called a *tissue.* Plants are made up of m iy types of complex tissues. All plants, except b ophytes—that is, mosses, liverworts, and h nworts—have conducting tissue that carries water, m erals, and other nutrients throughout the plant body. T s tissue is called *vascular tissue.* It is made up of two s cialized tissues called *xylem* and *phloem.* The xylem ti ue consists of cells that carry water and minerals fr n the roots to the leaves. The phloem tissue is made u of cells that carry food made by photosynthesis in th leaves to the other parts of the plant. Plants that have th se special tissues are called *vascular plants.* Bryop tes are called *nonvascular plants* because they lack xy m and phloem.

ı plant is made up of several important parts. Flowerir plants, the most common type of plants, have four m n parts: (1) roots, (2) stems, (3) leaves, and (4) flowers. T roots, stems, and leaves are called the *vegetative* p ts of a plant. The flowers, fruits, and seeds are known a he *reproductive* parts.

toots. Most roots grow underground. As the roots o young plant spread, they absorb the water and mine s that the plant needs to grow. The roots also anchor the plant in the soil. In addition, the roots of some plants store food for the rest of the plant to use. Plants with storage-type roots include beets, carrots, radishes, and sweet potatoes.

There are two main kinds of root systems—*fibrous* and *taproot.* Grass is an example of a plant with a fibrous root system. It has many slender roots of about the same size that spread out in all directions. A plant with a taproot system has one root that is larger than the rest. Carrots and radishes have taproots. Taproots grow straight down, some as deep as 15 feet (4.6 meters).

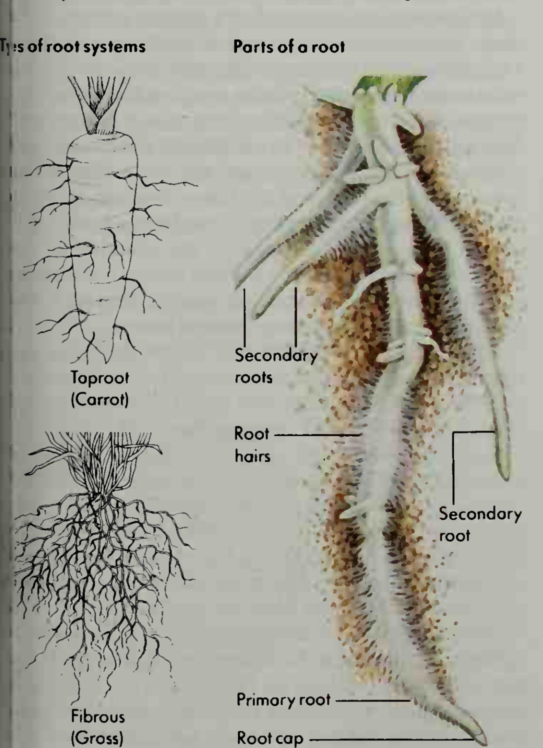
The root is one of the first parts of a plant that starts to grow. A *primary root* develops from a plant's seed and quickly produces branches called *secondary roots.* At the tip of each root is a *root cap* that protects the delicate tip as it pushes through the soil. Threadlike *root hairs* grow farther back on the root of the plant. Few of these structures are over $\frac{1}{2}$ inch (13 millimeters) long. But there are so many of them that they greatly increase the plant's ability to absorb water and minerals from the soil.

The roots of some aquatic plants float freely in the water. Other plants, such as orchids and some vines, have roots that attach themselves to tree branches.

The roots of almost all land plants have a special relationship with fungi. In this relationship, known as *mycorrhiza,* fungi cover or penetrate the growing tips of a plant's roots. Water and nutrients enter the roots through the fungi. Fungi extend the plant's root system

R ots

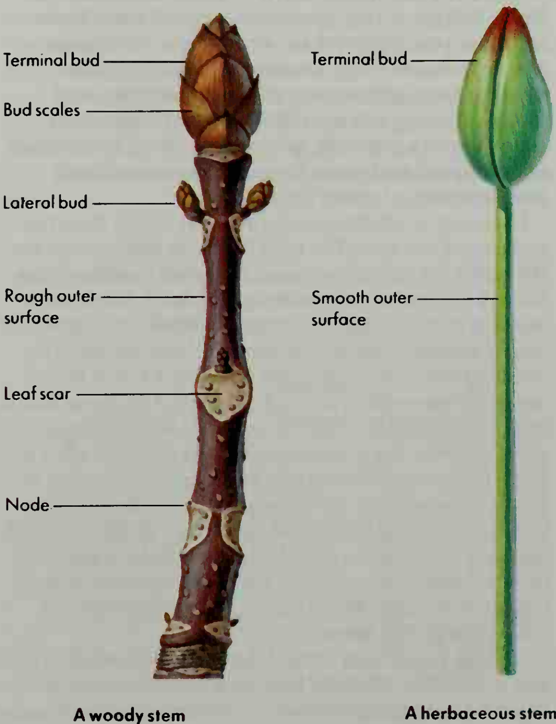
M st roots anchor a plant and absorb water and minerals. Plants h e either a fibrous root system or a taproot system, *below left.* T main parts of a root are shown below at the right.



Stems

Most stems support the plant's flowers and leaves. Stems are *woody* or *herbaceous.* A woody stem, *left,* has a rough, brown surface. A herbaceous stem, *right,* has a smooth, green surface.

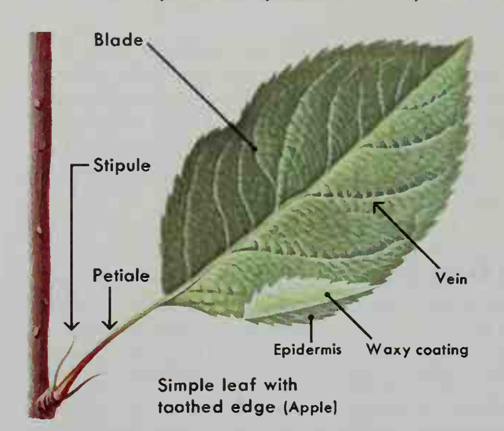
WORLD BOOK diagrams by James Teason and Margaret Ann Moran



A woody stem **A herbaceous stem**

Leaves The leaves of most plants make food for growth and repair. The first drawing here shows the main parts of a leaf. The other illustrations show the wide variety of leaf types and shapes. In addition to simple and compound leaves, they include scalelike, needlelike, and spinelike leaves.

WORLD BOOK diagram by James Teason and Marion



Simple leaf with toothed edge (Apple)

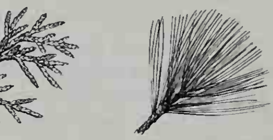


Simple leaf with smooth edge (Grass)

Simple leaf with lobed edge (Hepatica)



Compound leaf (American Wisteri



Scalelike leaves (Northern White Cedar)

Needlelike leaves (Eastern White Pine)



Spinelike leave (Cactus)

and improve the plant's ability to absorb water and minerals. Many botanists believe the first land plants developed millions of years ago from algae that lived in water. They think mycorrhizal relationships may have helped these plants to grow on land. See **Root.**

Stems of plants differ greatly among various species. They make up the largest parts of some kinds of plants. For example, the trunk, branches, and twigs of trees are all stems. Other plants, such as cabbage and lettuce, have such short stems and large leaves that they appear to have no stems at all. The stems of still other plants, including potatoes, grow partly underground.

Most stems grow upright and support the leaves and reproductive organs of plants. The stems hold these parts up in the air where they can receive sunlight. Some stems grow along the ground or underground. Stems that grow aboveground are called *aerial* stems, and those underground are known as *subterranean.* Aerial stems are either *woody* or *herbaceous* (nonwoody). Plants with woody stems include trees and shrubs. These plants are rigid because they contain large amounts of woody xylem tissue. Most herbaceous stems are soft and green because they contain only small amounts of xylem tissue.

In almost all plants, a stem grows in length from the end, called the *apex.* The cells that form this growth area are called the *apical meristem.* An apical meristem produces a column of new cells behind itself. These cells develop into the specialized tissues of the stem and leaves. A resting apical meristem and the cluster of developing leaves that surround it is called a *bud.* Buds may grow on various parts of the stem. A *terminal bud* is found at the end of a branch. A *lateral bud* develops at a point where a leaf joins the stem. This point is called a *node.* Buds may develop into new branches, leaves, or flowers. Some buds are covered with tiny overlapping leaves called *bud scales.* The bud scales protect the soft, growing tissue of the apical meristem. During the winter, the buds of many plants are *dormant* (inactive) and can be seen easily. In the spring, these buds resume their growth. See Stem.

Leaves make most of the food that plants need to live and grow. They produce food by a process called *photosynthesis.* In photosynthesis, chlorophyll in the leaves absorbs light energy from the sun. This energy is usec to combine water and minerals from the soil with carbon dioxide from the air. The food formed by this process is used for growth and repair, or it is stored i special areas in the stems or roots. See **Photosynthesi**

Leaves differ greatly in size and shape. Some plants have leaves less than 1 inch (2.5 centimeters) long and wide. The largest leaves, those of the raffia palm, grov up to 65 feet (20 meters) long and 8 feet (2.4 meters) wide. Most plants have broad, flat leaves. The edges, *margins,* of these leaves may be smooth, toothed, or wavy. Grass and certain other plants have long, slende leaves. A few kinds of leaves, including the needles of pine trees and the spines of cactuses, are rounded an have sharp ends.

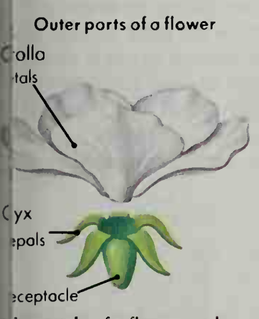
Most leaves are arranged in a definite pattern on a plant. The leaves of many kinds of plants grow in an *alternate* pattern. In this pattern, only one leaf forms a each node. On plants with the simplest kind of alterna pattern, a leaf appears first on one side of the stem an then on the other side. On plants with a more comple alternate pattern, the nodes are spaced in a *spiral* pattern around the stem and the leaves seem to encircle the stem from bottom to top. If two leaves grow from opposite sides of the same node, the plant has an *opp site* arrangement of leaves. If three or more leaves gro equally spaced around a single node on the stem, the plant has a *whorled* arrangement of leaves.

A leaf begins as a small bump next to the apical me stem of a stem. Most leaves develop two main parts— the *blade* and the *petiole.* The leaves of some plants a have a third part called *stipules.* The blade is the flat p of the leaf. Some leaves, called *simple* leaves, have on one blade. Leaves with two or more blades are called *compound* leaves. The petiole is the thin leafstalk that grows between the base of the blade and the stem. It carries water and food to and from the blade. Stipules are leaflike structures that grow where the petiole joi the stem. Most stipules look like tiny leaves.

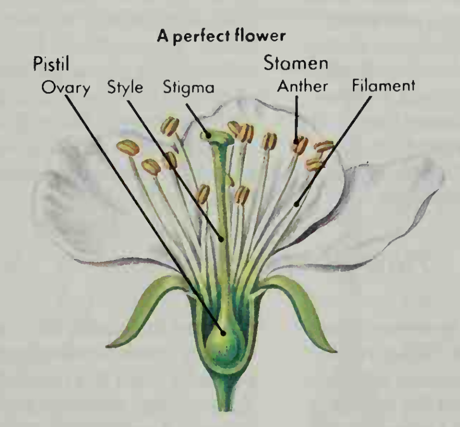
A network of veins distributes water to the food-pro ducing areas of a leaf. The veins also help support the leaf and hold its surface up to the sun. The upper and lower surfaces of a leaf are called the *epidermis* (skin) The epidermis has tiny openings called *stomata.* Carb

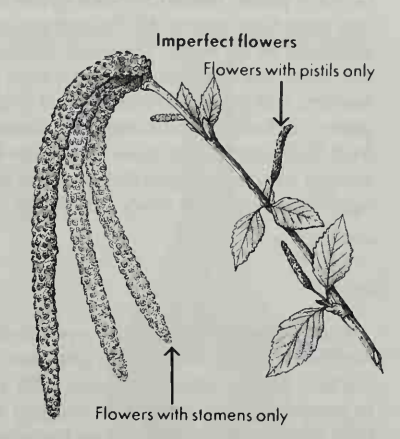
F wers Flowers contain the reproductive parts of flowering plants. If a plant's reproductive organs—its *stamens* and *pistils*—are in the same flower, the flower is called *perfect.* If a flower has only stamens or only pistils, it is called *imperfect.* The outer parts of a flower are shown below at the left.

WORLD BOOK diagram by James Teason and Marion Pahl



A he petals of a flower make u he corolla. The sepals fc n the calyx. The base is c ed the receptacle.





d xide, oxygen, water vapor, and other gases pass into tl leaves and out of the leaves through the stomata. S : Leaf.

lowers contain the reproductive parts of flowering p nts. Flowers develop from buds along the stem of a p nt. Some kinds of plants produce only one flower, b others grow many large clusters of flowers. Still oth- e such as dandelions and daisies, have many tiny fl vers that form a single, flowerlike head.

Aost flowers have four main parts: (1) the *calyx,* (2) the c *olla,* (3) the *stamens,* and (4) the *pistils.* The flower p ts are attached to a place on the stem called the *re- c tacle.*

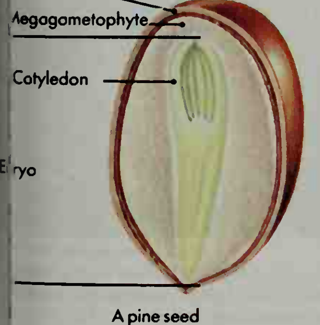
he calyx consists of small, usually green leaflike s ctures called *sepals.* The sepals protect the bud of a y ng flower. Inside the calyx are the petals. All the pet- a of a flower make up the *corolla.* The petals are the l jest, most colorful part of most flowers. The flower's r roductive organs—the stamens and the pistils—are a ched to the receptacle inside the sepals and the pet- a In many flowers, the stamens and petals are *fused* (j ned together).

stamen is a male reproductive organ, and a pistil is a female reproductive organ. Each stamen has an enlarged part called an *anther* that grows on the end of a long, narrow stalk called the *filament.* Pollen grains, which develop *sperm* (male sex cells), are produced in the anther. The pistils of most flowers have three main parts: (1) a flattened structure called the *stigma* at the top, (2) a slender tube called the *style* in the middle, and (3) a round base called the *ovary.* The ovary contains one or more structures called *ovules.* Egg cells form within the ovules. The ovules become *seeds* when sperm cells fertilize the egg cells. The next section of this article, *How plants reproduce,* tells how the sperm cells unite with the egg cells to begin the formation of seeds and fruit.

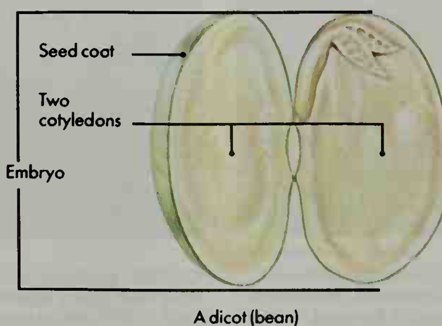
Seeds vary greatly in size and shape. Some seeds, such as those of the tobacco plant, are so small that more than 2,500 may grow in a pod less than $\frac{3}{4}$ inch (19 millimeters) long. On the other hand, the seeds of one kind of coconut tree may weigh more than 20 pounds (9 kilograms). The size of a seed has nothing to do with the size of the plant. For example, huge redwood trees grow from seeds that measure only $\frac{1}{16}$ inch (1.6 millimeters) long.

S ds All seeds are either *naked* or *enclosed.* A pine seed, *below left,* is a naked seed. It forms on a pinecone scale. There are two types of enclosed seeds—*monocots* and *dicots.* These seeds develop inside an ovary. A dicot, *center,* has two cotyledons. A monocot, *below right,* has only one.

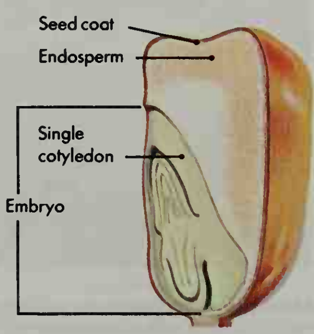
WORLD BOOK diagram by James Teason



A pine seed



A dicot (bean)



A monocot (corn)

There are two main types of seeds—*naked* and *enclosed.* Cone-bearing plants and all other nonflowering seed plants have naked, or uncovered, seeds. The seeds of these plants develop on the upper side of the scales that form their cones. All flowering plants have seeds enclosed by an ovary. The ovary develops into a *fruit* as the seeds mature. The ovaries of such plants as apples, berries, and grapes develop into a fleshy fruit. In other plants, including beans and peas, the ovaries form a dry fruit. Still other plants have *aggregate* fruits. Each tiny section of an aggregate fruit, such as a raspberry, develops from a separate ovary and has its own seed.

Seeds consist of three main parts: (1) the *seed coat,* (2) the *embryo,* and (3) the *food storage tissue.* The seed coat, or outer skin, protects the embryo, which contains all the parts needed to form a new plant. The embryo also contains one or more cotyledons, or embryo leaves, which absorb food from the food storage tissue. In flowering plants, the food storage tissue is called *endosperm.* In some plants, such as peas and beans, the embryo absorbs the endosperm, and food is stored in the cotyledons. In nonflowering seed plants, a tissue called the *megagametophyte* serves as a place to store food. See **Seed**.

How plants reproduce

Plants create more of their own kind by either *sexual reproduction* or *asexual reproduction.* In sexual reproduction, a male sperm cell joins with a female egg cell to produce a new plant. Both the egg and the sperm cells contain *genes* (hereditary material). Genes determine many of the characteristics of a plant. A plant that is produced by sexual reproduction inherits genes from both parent plants. It is a unique individual and has traits that may be different from either parent. Asexual reproduction can occur in many ways. It often involves the division of one plant into one or more parts that become new plants. These plants inherit genes from only one parent and have exactly the same characteristics as the parent plant. This type of asexual reproduction is called vegetative propagation. Many plants reproduce both sexually and by vegetative propagation.

Sexual reproduction

Sexual reproduction in plants occurs as a complex cycle called *alternation of generations.* It involves two distinct generations or phases. During one phase of the life cycle, the plant is called a *gametophyte,* or *gamete-bearing plant.* In most species of plants, the gametophyte is barely visible and is rarely noticed by people. It produces *gametes*—that is, the sperm and egg cells. It may produce sperm cells or egg cells, or both, depending on the species of plant. When the sperm and egg cells unite, the fertilized egg develops into the second phase of the plant's life cycle. In this phase, the plant is called a *sporophyte* or *spore-bearing plant.* When people see a plant it is most often the sporophyte phase. Sporophytes produce tiny structures called *spores* through a process of cell division called *meiosis.* The spores form in closed capsulelike structures called *sporangia.* Gametophytes develop from the spores, and the life cycle begins again.

In seed plants, which include flowering and cone-bearing plants, alternation of generations involves a series of complicated steps. Among these plants, only the sporophyte generation can be seen with the unaided eye. Spores are produced in the male and female reproductive organs of a plant. The spores grow into gametophytes, which remain inside the plant's reproductive organs.

In flowering plants, the reproductive parts are in the flowers. A plant's stamens are its male reproductive organs. Each stamen has an enlarged tip called an *anther.* The pistil is the plant's female reproductive organ. The ovary, which forms the round base of the pistil, contains the ovules. The anthers consist of structures called *microsporangia,* and the ovules contain structures called *megasporangia.* Cell divisions in the microsporangia and the megasporangia result in the production of spores.

In most species of flowering plants, one spore in each ovule grows into a microscopic female gametophyte.



Ken Brate, Photo Researchers

Many flowering plants are pollinated by bees and other animals. Grains of pollen become stuck to the animals, which carry them from flower to flower during their search for food.



Runk/Schoenberger from Grant Heilman

Conifers produce pollen grains that are carried by the wind from male cones to female cones. In this photograph, a male cone of an Austrian pine is shedding pollen.

w flowering plants reproduce

Fwering plants begin reproduction by a process called *pollination*. The process starts when a plen grain from the anther of a stamen reaches the stigma of a pistil. A long, hairlike pollen tube tn grows from the pollen grain to an ovule in the ovary. Sperm cells then move through the plen tube to the ovule. When one fertilizes an egg cell, a seed begins to develop.

WOLRD BOOK illustrations by Margaret Ann Moran and Emily McGowan

The anther splits open and frees pollen grains.

Anther

Stigma

Style

Ovary

Cross section of a perfect flower

Nuclei

Pollen grain

Stigma

Sperm cells formed from one nucleus travel through the pollen tube to the ovary.

Style

Pollen tube

Ovule

Ovary

Sperm cells

Style

Pollen tube

Polar nuclei

Ovule

Egg cell

Ovary

Fertilization occurs when the sperm cell unites with an egg cell.

Another sperm cell unites with the polar nuclei to produce an endosperm.

Seed

Seed coat

Endosperm

Embryo

The fertilized egg develops into a seed containing an embryo.

After the seed falls to the ground, the embryo grows into a new plant.

w conifers reproduce

T reproductive parts of conifers develop in separate male and female cones. Pollination begins wen pollen grains from a male cone enter the pollen chamber of an ovule in a female cone. Srm cells travel through the pollen tube, and one fertilizes an egg cell to produce a seed.

Female cone

Ovule (interior view)

Opening to pollen chamber

Scale of a female cone

Ovule

Seed coat

Egg cell

Pollen tube

Pollen chamber

Pollen grains become attached to a cone scale, enter the pollen chamber, and begin to grow pollen tubes toward the egg cells.

Megagametophyte

Egg cell

Sperm cell

Fertilization occurs when a sperm cell unites with an egg cell.

Male cones

Pollen grains

Seed

Seed coat

Embryo

Megagametophyte

The ovule develops into a seed containing an embryo with all the parts of a complete new plant.

Scale

Wing

Seed

The cone scale hardens after pollination. Each of its two ovules develops into winged seeds.

The mature cone opens and scatters its seeds to the wind.

After a seed falls to the ground, the embryo grows into a new plant

How plants grow

Plants can be divided into two groups, based on how they get their food. All green plants are called *autotrophs.* They contain chlorophyll, which enables them to capture the sunlight used in producing the food and other materials they need for growth. Other kinds of plants, called *heterotrophs,* lack chlorophyll and cannot make their own food. They are either parasites or saprophytes.

This section discusses the four major processes that take place in the growth of most kinds of green plants. These processes are (1) *germination,* (2) *water movement,* (3) *photosynthesis,* and (4) *respiration.* The section also discusses how a plant's heredity and environment affect its growth.

Germination is the sprouting of a seed. Most seeds have a period of inactivity called *dormancy* before they start to grow. In most parts of the world, this period lasts through the winter. Then, after spring arrives, the seeds start to germinate.

Seeds need three things to grow: (1) a proper temperature, (2) moisture, and (3) oxygen. Most seeds, like most kinds of plants, grow best in a temperature between 65° F. (18° C) and 85° F. (29° C). The seeds of plants that live in cold climates may germinate at lower temperatures, and those of tropical regions may sprout at higher temperatures. Seeds receive the moisture they need from the ground. The moisture softens the seed coat, allowing the growing parts to break through. Moisture also prepares certain materials in the seed for their part in seed growth. If a seed receives too much water, it may begin to rot. If it receives too little, germination may take place slowly or not at all. Seeds need oxygen for the changes that take place within them during germination.

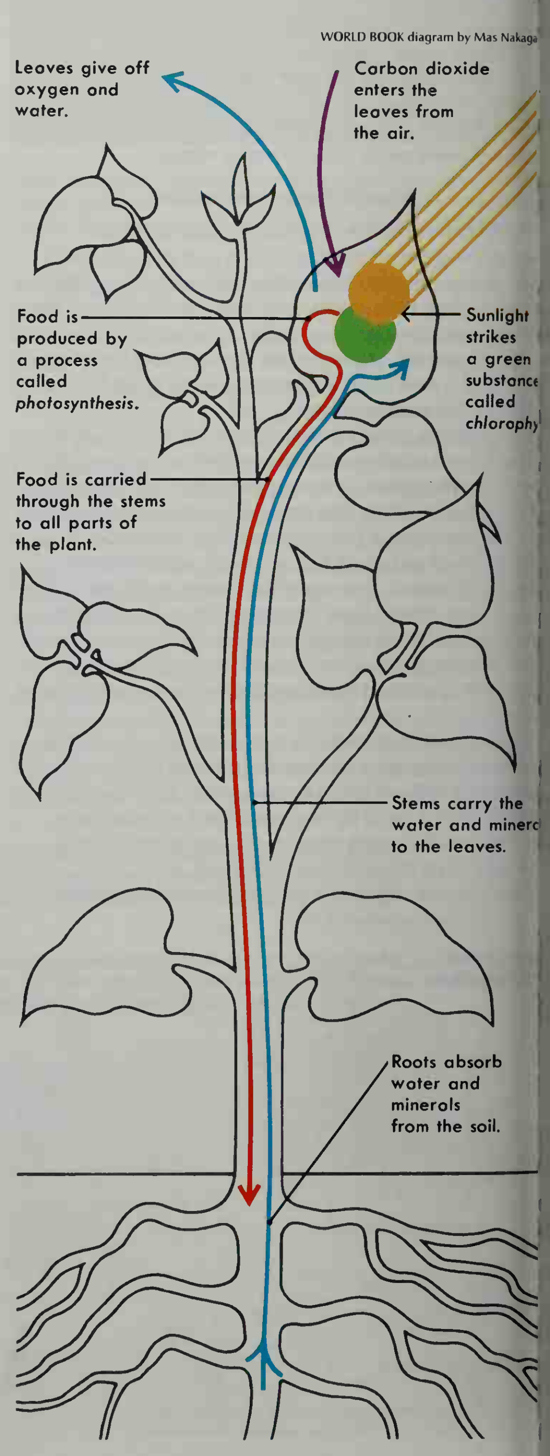
The embryo of a seed has all the parts needed to produce a young plant. It may have either one or more cotyledons, which digest food from the endosperm for the growing seedling. The seed absorbs water, which makes it swell. The swelling splits the seed coat, and a tiny seedling appears. The lower part of the seedling, called the *hypocotyl,* develops into the primary root. This root anchors the seedling in the ground and develops a root system that supplies water and minerals. Next, the upper part of the seedling, called the *epicotyl,* begins to grow upward. At the tip of the epicotyl is the *plumule,* the bud that produces the first leaves. In some plants, such as the many kinds of beans, the growth of the epicotyl carries the cotyledons above ground. In corn and other plants, cotyledons remain underground, within the seed. After a seedling has developed its own roots and leaves, it can make its own food. It no longer needs cotyledons to supply nourishment.

Most plants grow in length only at the tips of their roots and branches. The cells in these areas are called *meristematic* cells. They divide and grow rapidly and develop into the various tissues that make up an adult plant. In trees and other plants that increase in thickness, new layers of cells form between the bark and wood. This area is the *cambium.* New layers of cells are made as the cambium grows each year. These layers form the woody rings that enable people to tell the age of a tree.

Some kinds of plants, called *perennial* plants, live for many years. Most perennials produce seeds yearly.

Growth of a green plant

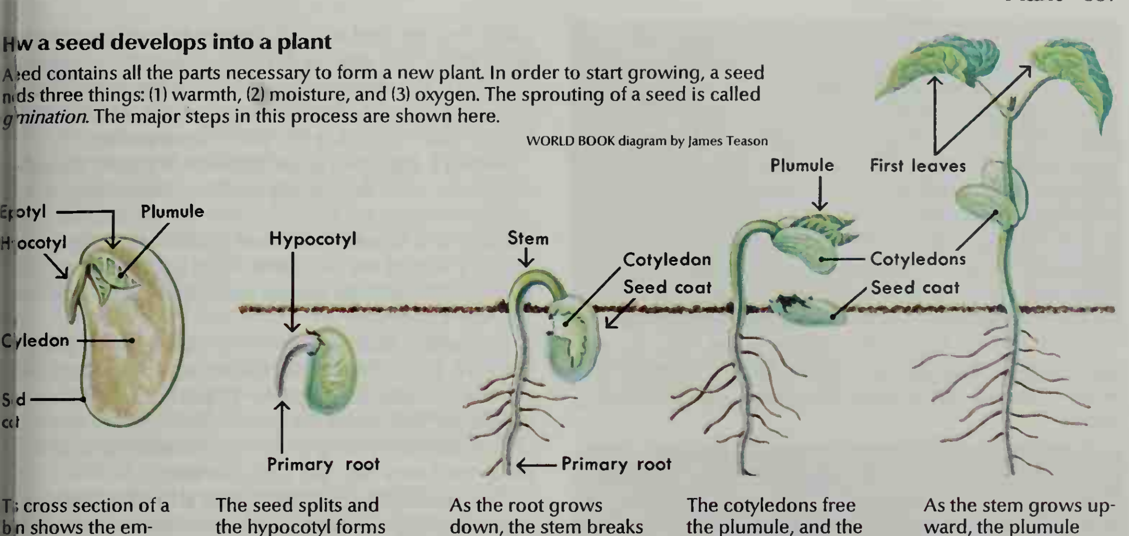
Green plants make the food they need by a process called *pho-tosynthesis.* This process, which occurs chiefly in the leaves, is triggered by chlorophyll. The chlorophyll interacts with water from the soil, carbon dioxide from the air, and light from the s to produce food. Most plants have special conducting tissue that carries food through the stems to all parts of the plant. Th food is needed for growth, repair, and storage.



Hw a seed develops into a plant

A ed contains all the parts necessary to form a new plant. In order to start growing, a seed n ds three things: (1) warmth, (2) moisture, and (3) oxygen. The sprouting of a seed is called *g mination.* The major steps in this process are shown here.

WORLD BOOK diagram by James Teason



T cross section of a b n shows the em- b in a seed coat.

The seed splits and the hypocotyl forms the primary root.

As the root grows down, the stem breaks through the soil.

The cotyledons free the plumule, and the seed coat drops off.

As the stem grows upward, the plumule forms the first leaves.

A nual plants live only about one year. *Biennial* plants li for two years. Most annuals and biennials produce s ds only once. See **Annual; Biennial; Perennial.**

Vater movement. Plants must have a continuous s ply of water. Each individual plant cell contains a l je amount of water. Without this water, the cells c ld not carry on the many processes that take place v hin a plant. Water also carries important materials f n one part of a plant to another.

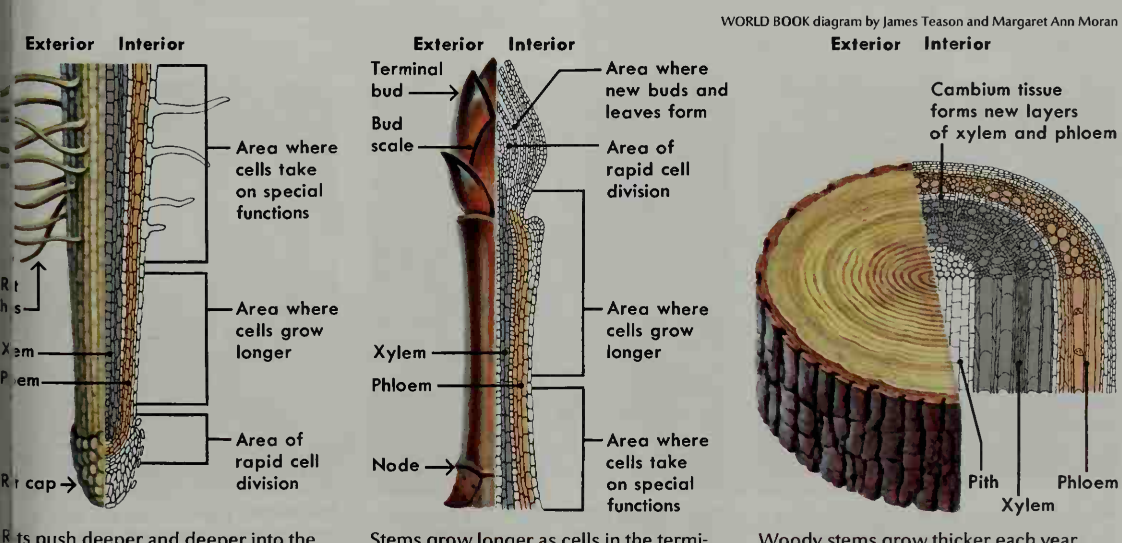
Most water enters a plant through the roots. Tiny root h rs absorb moisture and certain minerals from the soil b a process called *osmosis* (see **Osmosis**). In many p nts, fungi that grow on the roots help the plants absorb water and minerals. In vascular plants—that is, plants with special conducting tissues—these materials are transported through the xylem tissue of the roots and stems to the leaves. There, water and minerals are used in making food. Water also carries this food through the phloem tissue to other parts of the plant.

Plants give off water through a process called *transpiration.* Most of this water escapes through the stomata on the surfaces of the leaves. Scientists estimate that corn gives off 325,000 gallons of water per acre (3,040,000 liters per hectare) by transpiration during a growing season. Some botanists believe this water loss prevents the leaves from overheating in sunlight.

w plants grow longer and wider

N st plants grow only at the tips of their roots and stems. Cells in these areas grow rapidly, form- i the various tissues that make up an adult plant. Trees and other plants that grow wider develop a w layer of tissue just below the bark each year. The growing parts of plants are shown here.

WORLD BOOK diagram by James Teason and Margaret Ann Moran



R ts push deeper and deeper into the s as cells just in back of the root cap d de and grow longer.

Stems grow longer as cells in the terminal bud divide rapidly. These cells will develop into buds, flowers, and leaves.

Woody stems grow thicker each year. New growth comes from the rapidly dividing cells that make up the cambium.

Photosynthesis is the process by which plants make food. The word *photosynthesis* means *putting together with light.* In green plants, sunlight captured by chlorophyll enables carbon dioxide from the air to unite with water and minerals from the soil and create food. This process also releases oxygen into the air. People and animals must have this oxygen to breathe.

Most photosynthesis takes place in small bodies called *chloroplasts* within the cells of plant leaves. These chloroplasts contain chlorophyll, which absorbs sunlight. Energy from the sun splits water molecules into hydrogen and oxygen. The hydrogen joins with carbon from the carbon dioxide to produce sugar. The sugar helps a plant make the fat, protein, starch, vitamins, and other materials that it needs to survive. See **Photosynthesis.**

Some plants, called *parasites* and *saprophytes,* have little or no chlorophyll and cannot produce their own food through photosynthesis. These plants must rely on outside sources for food. Parasites attach to living plants and take the nutrients they need from these plants. Saprophytes grow on dead and decaying organisms, or use organic substances produced by living organisms for food.

Mistletoe and dodder are common parasites found in many parts of the world. Mistletoe grows on the trunks and branches of many trees. It is called a *partial parasite* because it also makes some of its own food. Indian pipe is a saprophyte that grows near fungi. It uses organic materials produced by fungi for food. A plant called giant rafflesia is a parasite that grows on the roots and stems of other plants. It bears the largest flower of any known plant. Rafflesia flowers may grow over 3 feet (91 centimeters) wide.

Respiration breaks down food and releases energy for a plant. The plant uses the energy for growth, reproduction, and repair. Respiration involves the breakdown of sugar. Some of the products resulting from this breakdown combine with oxygen, releasing carbon dioxide, energy, and water. Unlike photosynthesis, whic takes place only during daylight, respiration goes on day and night throughout the life of a plant. Respiratio increases rapidly with the spring growth of buds and leaves, and it decreases as winter approaches.

Factors affecting plant growth. A plant's growth i shaped by both its heredity and its environment. A plant's heredity, for example, determines such characteristics as a flower's color and general size. These hereditary factors are passed on from generation to gen ation. Environmental factors include sunlight, climate, and soil condition.

Hereditary factors. Within the nucleus of all plant cells are tiny bodies called *chromosomes* that contain hereditary units called *genes.* These bodies contain "ir structions" that direct the growth of the plant. As the cells divide and multiply, the "instructions" are passed on to each new cell. See **Cell; Heredity.**

Substances made within a plant also play a part in regulating plant growth. These substances, called *hormones,* control such activities as the growing of roots and the production of flowers and fruit. Botanists do n know exactly how all plant hormones work. But they have learned that certain hormones, called *auxins,* affe the growth of buds, leaves, roots, and stems. Other growth hormones, called *gibberellins,* make plants grow larger, cause blossoming, and speed seed germi nation. Still other hormones called *cytokinins* make plant cells divide.

Environmental factors. All plants need light, a suitable climate, and an ample supply of water and miner from the soil. But some species grow best in the sun, and others thrive in the shade. Plants also differ in the amount of water they require and in the temperatures they can survive. Such environmental factors affect the rate of growth, the size, and the reproduction of all plants.

The growth of plants also is affected by the length o the periods of light and dark they receive. Some plants

How nongreen plants get their food

Nongreen plants cannot make their food. *Parasites* get food from other living things. *Saprophytes* live on decaying organisms or on substances made by living organisms.



Edward S. Ross

Mistletoe, *above,* grows on trees. It is a partial parasite because it takes water and minerals from trees but makes food in its own leaves.



Edward S. Ross

The dodder plant, *above,* is a parasite. This plant grows in tangled masses. It gets its food by inserting specialized roots called *suckers* into other plants.



© Steve Solum, Bruce Coleman

The Indian pipe, *above,* is a saprophy This plant grows near fungi and uses th organic materials produced by the fun for food.

iruding lettuce and spinach, bloom only when the
p*toperiod* (period of daylight) is long. Such plants are
c.ed *long-day* plants. On the other hand, asters, chry-
s.themums, and poinsettias are *short-day* plants. They
bom only when the dark period is long. Still other
pnts, among them marigolds and tomatoes, are not af-
fted by the length of the photoperiod. They are called
d-neutral plants.

'lants also are affected in other ways by their environ-
nnt. For example, a plant may display a bending move-
nnt called a *tropism.* In a tropism, an outside *stimulus*
(fce) causes a plant to bend in one direction. A plant
ny have either a *positive* or a *negative* tropism, de-
pnding on whether the plant bends toward or away
fm the stimulus. Tropisms are named according to the
snuli that cause them. *Phototropism* is bending caused
t light, *geotropism* is caused by gravity, and *hydrotro-*
m is caused by water.

A plant placed in a window exhibits positive photot-
rpism when its stems and leaves grow toward the
surce of light. Roots, on the other hand, display nega-
te phototropism and grow away from light. However,
rots demonstrate positive geotropism. Even if a seed or
llb is planted upside down, its roots grow down-
rd—toward the source of gravity. The stem of the
ne bulb shows negative geotropism by growing
ward—away from the source of gravity. Hydrotropism
curs chiefly in roots and is almost always positive. See
opism.

Some plants are affected by being touched. When the
nsitive plant, *Mimosa pudica,* is touched, its leaflets
ickly fold and its branches fall against its stem. A
ange in pressure within certain cells of the plant
uses this action. After the stimulus has been removed,
e plant's branches and leaflets return to their original
sition.



Henry M. Cathey, U.S. Department of Agriculture

The amount of daylight received by a plant affects its growth. The petunias above are the same age. They have received, *from left to right,* 8, 12, 16, 20, and 24 hours of light per day.



Runk/Schoenberger from Grant Heilman

Hormones can affect plant growth. In the experiment shown above, the plant cutting at the left was treated with the hormone *naphthalene acetic acid.* The cutting on the right was untreated.



Grant Heilman

eotropism, the effect of gravity on plants, can be shown by lanting corn kernels upside down, *above.* Roots have positive eotropism and grow downward toward the source of gravity.



Walter Dawn

Phototropism is a bending movement caused by light. The stem of the coleus plant shown above demonstrates positive phototropism. It is growing toward a fixed source of light.

How plants change

Plants—like animals—compete with one another for sunlight, water, and other necessities of life. Some plants—like some animals—are better able than others to grow and reproduce. After thousands of years, those that survive may differ greatly from their ancestors. The surviving plants have adapted to their environment through a process called *natural selection* or survival of the fittest (see **Natural selection**).

This section traces the early history of plants and discusses important forms of plant adaptation for water storage and seed *dispersal* (scattering). This section also describes an unusual group of plants that adapted in such a way that they capture and eat insects. It ends with a discussion of some of the ways that people have changed plants.

Early plants. The first land plants appeared on the earth over 430 million years ago during the Paleozoic Era. These plants were very simple and did not resemble any of the plants we see today. They probably had a sticklike plant body and lacked the specialized water-conducting tissue of vascular plants. Many botanists believe these early land plants are the ancestors of primitive vascular plants. The first vascular plants, called *Rhyniophytes,* did not have leaves or roots. They consisted of both stems that grew along the ground and stems that grew upright with Y-shaped branches. These plants probably grew as tall as 2 to 3 feet (60 to 90 centimeters).

Larger plants called *Trimerophytes* may have developed from the Rhyniophytes. The Trimerophytes had a more complex plant body with numerous stems and branches. But they did not have leaves, and only some of them may have had simple roots. Other small vascu plants called *Zosterophyllophytes* appeared shortly aft the Rhyniophytes and also may have descended from them. Some botanists believe Trimerophytes and Zosterophyllophytes are the ancestors of all vascular plan that exist today. They think that ferns, horsetails, and seed-bearing plants *evolved* (developed through progressive change) from Trimerophytes about 408 millio to 360 million years ago. Club mosses, quillworts, and selaginellas are believed to have evolved from Zostero phyllophytes about that same time.

When the first vascular plants began to grow succes fully on much of the land, life on earth was very differe than it is today. No leaves rustled in the breeze, few insects crawled about, and no *vertebrates* (animals with backbones) lived on land. However, as conditions on th earth changed, new plants and animals developed. Du ing the Carboniferous Period, about 360 million to 286 million years ago, more complex and larger vascular plants evolved. Great forests of lycopsid trees, ferns, horsetails, and early seed plants covered the earth. The huge plants of this period died and accumulated in vas swamps. They later formed large coal deposits. Most of the coal found in the eastern and midwestern United States is made up of these plants.

WORLD BOOK illustration by James Teas

About 410 million years ago, forests began to grow in swampy regions of the world. The plants of these early forests included the ancestors of present-day club mosses, horsetails, and ferns. The first amphibians and insects also appeared about the same time.



Paul Meyer, Tom Stack & Assoc.

Desert plants have many features that enable them to survive in extremely dry areas. The barrel cactuses, *shown here,* store water from infrequent rains in their thick, fleshy stems.

ymnosperms became the most plentiful plants dur-
i the Mesozoic Era, beginning about 248 million years
a. Conifers, cycads, and ginkgoes were among the
st important plants. They served as food for the great
osaurs that roamed the land during this period.
ny now-extinct types of gymnosperms also flour-
ed. The first angiosperms, or flowering plants, ap-
ared near the end of the Mesozoic Era. Among them
re magnolias, sycamores, willows, water lilies, and
ny other present-day flowering plants.

During the Cenozoic Era, beginning about 65 million
ars ago, forests of angiosperms covered much of the
pical and temperate regions of the earth. Grasslands
d large grazing animals began to appear late in the
nozoic Era. Some scientists believe that humanlike
atures appeared on the earth about 5 million years
o and lived in the regions between the forests and
asslands.

Water storage. Through the years, many species of
ants have developed special methods for collecting
d storing water that enabled them to survive in areas
little rainfall. Some cactuses, for example, have roots
at spread over large areas just below the surface of
e ground. These roots quickly absorb water from the
ht rains and sudden floods that occur on the desert.
ctuses store the water in their fleshy stems.

Through natural selection, the leaves of cactuses
olved into spines. As a result of this adaptation, cac-
ses have less green surface than do most plants of
eir size—and they lose less water through transpira-
n. Because cactuses have such specially shaped
aves, they carry out photosynthesis in their stems. Dur-
g photosynthesis, cactuses use their stored water sup-
y if water from their roots is not available.

Plants of the tundra also have adapted to the dry con-
tions created by frozen soils. The surfaces of their
aves are especially resistant to water loss. They are ei-
er hard and glossy or very hairy. In addition, tundra
ants grow close to the ground, where they are covered by snow and thus protected from the strong winds of these regions.

Seed dispersal. Seeds play an important part in the distribution of plants to nearly every part of the world. If seeds simply fell to the ground, all the plants of each species would be found in the same area. People also have helped spread seeds by taking food crops and certain other plants wherever they have settled.

lants that eat insects

sect-eating plants grow in soil that lacks important minerals, especially nitrogen. Special organs
able these plants to trap and digest insects whose bodies contain the minerals.



Lincoln Nutting, NAS

sects caught in a pitcher plant drown
rain water collected in the plant's slen-
er, tube-shaped leaves.



Ross E. Hutchins

A sundew plant has sticky hairs on its leaves that trap insects and then cover them with digestive fluids.



Howard A. Miller, Sr., NAS

The leaves of Venus's-flytrap close quickly on an insect. They open after the victim has been digested.

Seeds have many features that have helped them be scattered across large regions. The wind carries many seeds, including the winglike ones of the maple tree and the fluffy seeds of dandelion and milkweed plants. Some seeds, such as those of the coconut, may float on water from one land area to another.

Animals also help distribute seeds. Some plants have burs and sticky substances which cling to the fur or feathers of animals that migrate from one region to another. Many kinds of animals eat berries and fruits but do not digest the seeds. The seeds are dispersed as part of the body waste of these animals.

A few species of plants distribute their own seeds. For example, a wild flower called the touch-me-not shoots out its seeds at the slightest touch.

Insect-eating plants grow chiefly in areas where the soil lacks an adequate supply of important minerals, especially nitrogen. These plants have adapted so that they can obtain needed minerals by trapping and digesting insects in their leaves. These *carnivorous* plants also manufacture their own food by photosynthesis. Insect-eating plants include the pitcher plant, the sundew, and Venus's-flytrap.

Pitcher plants have tube-shaped leaves that collect rain water. Sweet substances around the rim of each tube attract insects to the plant. After an insect enters the tube, tiny, downward-pointing hairs keep the struggling victim from escaping. In time, the insect becomes exhausted, slides into the water, and drowns. The plant then digests the insect by means of a fluid secreted by glands located in the leaves.

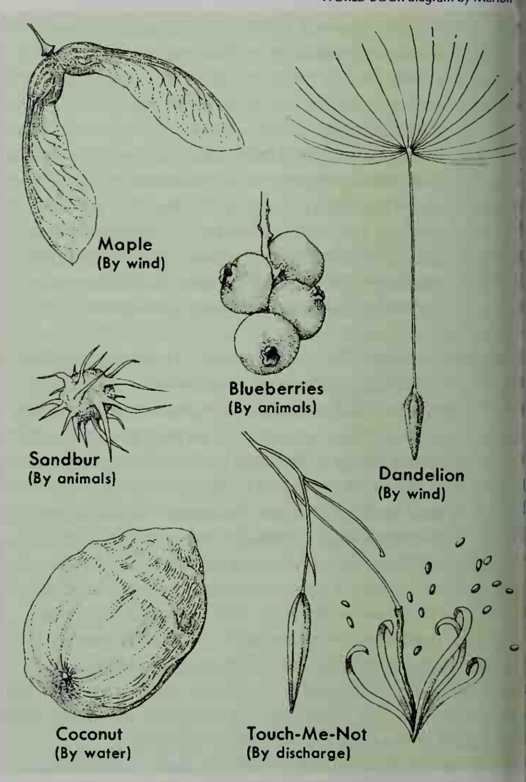
The leaves of the sundew plant grow hairs that give off a sticky substance that contains digestive juices. When an insect gets stuck on this substance, the hairs wrap around it. More fluid covers and suffocates the insect, which is then gradually digested by the sundew plant.

Venus's-flytrap has hinged leaves that trap insects.

How seeds are dispersed

Seeds have a variety of features that help them to be scattered to almost every part of the world. People and animals also help disperse seeds in a number of ways.

WORLD BOOK diagram by Marion



The inside of each leaf has hairs, and the rim is edged with sharp bristles. When an insect lands on the hairs, the two halves of the leaf close like a trap, with the bristles interlocking. After the plant has digested the insect, the leaves open up again.

How people have changed plants. People began to play an important role in changing plants about 10,000 years ago, when they learned to raise food by farming. Early farmers noted that some plants grew better than others. They saved seeds from these plants to grow new ones. The basic food crops of the world were developed in this way. For example, the Indians of the Americas developed tiny ears of wild corn into large cobs with many kernels. By the time Christopher Columbus reached the New World in 1492, this improved corn was being raised over large areas of the Americas.

The scientific study of plants has greatly aided our attempts to make plants more useful and attractive. For example, an Austrian monk named Gregor J. Mendel conducted experiments on garden peas in the mid-1800's that laid the foundation for the field of *genetics,* the science of heredity. Using the laws of genetics, scientists have greatly increased the yield of such crops as corn, rice, and wheat. They also have developed plants that can resist the attacks of various diseases and insects. In 1970, Norman E. Borlaug, an American agricultural scientist, received the Nobel Peace Prize for developing high-yield, disease-resistant wheat.



Michael D. Coe

Large ears of corn were developed by the American Indians from tiny cobs of wild corn, *above.* Today, botanists seek ways to improve crop yields and develop disease-resistant plants.

Plant enemies

Various kinds of plant enemies attack and injure al-
[illegible]st all species of plants throughout the world. Dis-
[illegible]es and insect pests rank as the major enemies of
[illegible]nts. They cause serious, widespread damage to agri-
[illegible]ltural, garden, and ornamental plants, many of which
[illegible]ve lost the natural defenses present in wild plants. In
[illegible] United States, diseases, insects, and other plant ene-
[illegible]es cause crop losses totaling about $30 billion yearly.
[illegible]seases reduce the nation's total annual crop produc-
[illegible]n by 10 to 15 per cent, and insects reduce it by about
[illegible]other 15 per cent.

Widespread outbreaks of plant diseases can cause [illegible]nine. During the 1840's, about 750,000 people in Ire[illegible]nd died after a fungus disease destroyed the nation's [illegible]tato crop. Other diseases have killed large numbers [illegible] certain species of plants. For example, a fungus dis[illegible]se called *chestnut blight* has destroyed the chestnut [illegible]e throughout North America. Insects also severely [illegible]mage large numbers of plants. Swarms of grasshop[illegible]rs have destroyed entire crops of alfalfa, cotton, and [illegible]rn. Gypsy moths have damaged forests in the North[illegible]stern United States and are spreading to other areas. [illegible] addition, many plants are injured or killed by animal [illegible]sts, including mites, rabbits, and rodents.

Diseases in plants are caused by many kinds of mi[illegible]oorganisms, including certain fungi, bacteria, viruses, [illegible]d small worms called *nematodes.* Fungi cause more [illegible]ant diseases than the other microorganisms. Viruses [illegible]so infect plants with serious diseases.

Certain conditions in the environment can damage [illegible]ant tissues and weaken plants so that they are more [illegible]sily infected by disease-causing microorganisms. [illegible]uch conditions include air pollution, unusually high or [illegible]w temperatures, lack of proper nutrients in the soil, [illegible]d low levels of light or oxygen.

Plant diseases may affect every part of the plant. Many [illegible]iseases interfere with the plant's ability to carry out [illegible]hotosynthesis by damaging leaves or by blocking the [illegible]ow of water or nutrients to stems and leaves. Fungi, [illegible]acteria, or viruses may invade plant tissues and kill cells in a small area. For example, dead spots on leaves and fruits, or yellowing and death of leaves at the edges, indicate places where microorganisms have killed plant cells. Abnormal growths, such as *galls* and *knots,* on roots, stems, and other parts of the plant also signal places of infection. Fungi or bacteria that invade the roots, stems, and leaves can prevent xylem tissue from transporting water throughout the plant. As a result, the leaves, stems, and flowers may wilt or suddenly die. In addition, fungi may secrete *toxins* (poisons) that cause large parts of the plant to die.

Fungal diseases are spread from plant to plant by the spores of the fungi. These spores are carried by insects, rain, wind, and even people. Some bacteria and viruses are spread in the same way. Nematodes not only cause certain diseases but also transmit viruses from diseased to healthy plants. Some bacteria and fungi live on plant refuse in the soil and infect healthy plants. Others are carried on the seeds of plants.

Some diseased plants cause serious illness when eaten by human beings and animals. For example, a fungus called *ergot* infects wheat, barley, and rye. It produces chemicals that can cause *ergotism,* an illness that afflicts people who eat bread made from the infected grain. Other fungi, if enough are present on food or animal feed, produce harmful chemicals called *mycotoxins.* Scientists are conducting extensive research on these chemicals, some of which may cause cancer.

Nutrient deficiencies. Plants suffer from *nutrient deficiencies* when they cannot obtain certain minerals and chemicals from the soil. Nutrient deficiencies are harmful to plants in a number of ways. They may cause changes in leaf color, reduction in the size of leaves, dead spots on leaves and stems, reduced growth, and wilting. Each symptom often can be linked to the lack of a specific chemical, usually nitrogen or potassium.

Plants may also be affected by *chemical toxicity* when the soil contains too much of certain chemicals or minerals. For example, most plants require very small amounts of zinc, iron, and copper. But people some-



Sherman V. Thomson

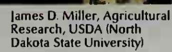




Sherman V. Thomson

[illegible] **bacterial disease called fire blight** has killed most of the [illegible]eaves of the pear tree at the left. The photograph at the right [illegible]hows hundreds of the microscopic fire blight bacteria.





James D. Miller, Agricultural Research, USDA (North Dakota State University)



Runk/Schoenberger from Grant Heilman

A fungal disease called black stem rust attacks wheat stalks, *left.* A photograph of an infected stalk seen under a microscope, *right,* shows the reddish-black fungal spores.

times introduce excessive amounts of these substances into the soil during the mining and smelting of ore. As a result, large numbers of plants are killed. Zinc also may accumulate in the soil below fences that are coated with the mineral to prevent them from rusting. The zinc builds up in a narrow strip of soil and eventually destroys many of the plants growing there.

Some soils are naturally too rich in metals. For example, areas of *serpentine,* a volcanic rock that contains heavy metals, are common in western North America. These areas form *barrens* where few plants survive.

Pests. Insects damage or destroy plants in a number of ways. Insects with chewing mouthparts, such as beetles and grasshoppers, eat holes in leaves and stems. Other insects have piercing and sucking mouthparts with which they pierce plants and consume the plant juices. Some insects feed on flowers and fruit. The destruction of leaves by insects affects the growth and yield of crops because photosynthesis is reduced. In addition, wounds made in plants by insects provide places for disease-causing organisms to enter the plants easily.

Some insects secrete poisons or other chemical substances while feeding. These secretions may cause galls on leaves or roots or give leaves a "burned" appearance. Other insects interrupt the flow of food and water in plants by feeding on phloem and xylem tissue.

Mites, which have sucking mouthparts, injure plants by feeding on them. Rabbits and rodents gnaw on plants. Some kinds of rodents burrow into the soil and feed on the roots, seeds, and bulbs of plants.

How plants protect themselves. Insects and many other animals eat plants. To avoid being eaten, many species of plants have developed physical and chemical defenses. Many plants also protect themselves through the timing of when they produce flowers and fruits.

Physical defenses of plants include such structures as spines, thorns, and prickles. These structures, which are usually modified leaves or branches, prevent attacks by large plant-eating animals. Heavy coatings of wax or dense, stiff hairs on leaves and stems may repel smaller



Jane Burton, Bruce Coleman Ltd.

Insects damage large numbers of plants. Locusts, shown here devouring the leaves of a corn plant, are among the most destructive pests. Swarms of locusts can destroy an entire crop.



E. R. Degginger, Earth Scen

The leaves and stems of poison ivy, *above,* contain a poisonous oil that is extremely irritating to the skin. The oil helps protect the plant from animals and human beings.

animals, especially insects. Some plants, including grasses, accumulate a hard mineral called *silica* in their leaves. The silica makes the leaves difficult for animals to chew and rapidly wears down their teeth.

Certain species of plants obtain protection from animal enemies through a relationship called *mutualism.* In this relationship, the plant provides a special type of food for a particular group of insects. The insects, in turn, protect the plant from other animals. One example of plant-insect mutualism is the relationship between ants and acacia trees in some dry regions of the world. Ants live in hollow thorns on the acacia trees, and the leaves of the trees release a sugar solution for the ants to eat. In return, the ants clear the ground around each tree and attack any other animals that enter the cleared area or that land on the trees.

Plants have a wide variety of chemical defenses against animals. The leaves and fruits of citrus plants produce sticky, strong-smelling oils that discourage many insects. Many plants contain chemicals that have an unpleasant taste or are poisonous. Such plants include nightshade, foxglove, yew, and many weeds.

Insects can quickly become immune to the chemicals plants produce. In some cases, certain kinds of insects develop a means of breaking down the toxic compounds produced by the plants. As a result, plants continually develop new chemical compounds by altering existing ones. Some scientists describe this process as a biological "arms race" between plants and their predators. In other cases, the "arms race" between an insect and plant has resulted in a unique relationship. For example, plants in the milkweed family produce a milky sap that contains poisonous chemicals. The chemicals prevent most insects from eating the plants. However, caterpillars of monarch butterflies are able to eat milkweed plants and store the poison in their bodies. The poison makes monarch butterflies distasteful and so protects them from many predators.



Camouflage helps protect certain plants from animals that feed on them. This photograph shows five living rock cactuses. Their color and shape make them barely distinguishable from surrounding rocks.

© Breck P. Kent, Earth Scenes

Many plants try to ensure the survival of their seeds rough the timing of flower and fruit production. Some ants produce flowers and fruits very early in the grow-g season, when insect populations are small. Other ants produce so many seeds that animals cannot eat em all. For example, oak trees produce a great num-er of acorns every few years. When acorns are abun-nt, squirrels and other animals cannot eat all of them id some acorns survive to grow into new oak trees. In her years, oak trees do not produce an abundance of corns and thus prevent animals from relying on acorns r food. If the trees produced a surplus of acorns each ear, the animal population would increase and all the corns would be eaten.

Control of diseases and pests. People fight plant iseases and pest damage by means of (1) genetic meth-ds, (2) physical methods, (3) sanitation, (4) chemicals, (5) biological control, and (6) quarantine laws. Genetic methods include the development of resistant varieties of plants by plant breeders. Breeders cross resistant plants with other varieties of the same species to develop new varieties that combine resistance with high yield and other desirable characteristics. Such efforts by plant breeders have resulted in the development of high-yield, rust-resistant wheats, for example.

Physical methods include such barriers against plant pests as sticky bands of paper that trap insects, and wire guards to keep rodents away. Plant growers also gather and destroy insects and insect eggs found on plants. Crop rotation and plowing help prevent plant enemies from overpopulating the soil.

Sanitation includes destroying diseased plants and disinfecting planting equipment. In addition, refuse is removed from a growing area. This removal eliminates places where insects and disease-causing organisms may reproduce.

Chemicals make up the largest part of almost every program to control plant enemies. Diseases and pests may attack suddenly, and chemicals may be the only means of saving the plants. Many chemicals protect plants from diseases and pests. They include bactericides, fungicides, insecticides, nematocides, and rodenticides. In the United States, such chemicals must be approved by the Environmental Protection Agency before they can be marketed.

Biological control involves the use of natural processes to fight the insects and disease organisms that attack plants. For example, certain bacteria and viruses that cause diseases in beetles and caterpillars may be introduced into an area to control those insects. Similarly, animals that prey on insects may be introduced to control plant enemies. Another example of biological control is the capture of insects in traps baited with *sex attractants,* the natural chemicals that insects secrete to attract mates.

Quarantine laws regulate the shipment of plants between countries and, in the United States, between states. These laws require inspection of plants to prevent the introduction and spread of plant diseases and insect pests. William A. DiMichele



Raymond F. Hillstrom

Chemicals play a major role in controlling plant enemies. A crop duster, *above,* can rapidly spray an entire field with chemicals that protect against various diseases and pests.

Classification of plants

Botanists classify plants by grouping them according to their shared similarities. Such an arrangement provides a logical way to organize information about plants and show how different plants are related to each other.

Most botanists group plants by their overall appearance, their internal structure, and the form of their reproductive organs. However, not all botanists agree on how plants should be divided, and there are a number of different classifications of the plant kingdom. One frequently used classification system is described below. This system classifies plants into 2 large groups or div sions. A division is the same grouping as a phylum in the animal kingdom.

One division, Bryophyta, is made up of *nonvascular plants.* These plants lack xylem and phloem tissues tha carry water and food from one part of the plant body t another. The other division, Tracheophyta, consists of *vascular plants* that contain these specialized tissues. Within the divisions are several smaller groupings, including subdivisions, classes, subclasses, and orders.

WORLD BOOK illustrations by Marion Pahl and Paul D. Turnba

Nonvascular plants

Division Bryophyta

Liverworts, hornworts, and mosses make up this division of plants. These plants reproduce by means of spores and lack true leaves, stems, or roots. Most live in moist areas. However, some mosses can withstand severe temperatures and are found in Arctic or desert regions.

Class Hepaticae

Liverworts make up this class. These small plants may be flat and ribbon-shaped or leafy. They grow close to the ground.

Class Anthocerotae

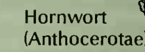
Hornworts usually grow only $\frac{3}{8}$ to $\frac{3}{4}$ inch (1 to 2 centimeters) across. The gametophyte is ribbonlike. Spores are contained in tubular sporangia that grow continuously from the sporangium base.

Class Musci

True mosses make up this class. Stems may be erect or horizontal and bear many leaflike growths. They seldom grow over 8 inches (20 centimeters) long.



Leafy liverwort (Hepaticae)



Hornwort (Anthocerotae)



Moss (Musci)

Vascular plants

Division Tracheophyta

Tracheophytes are the vascular plants. All have two kinds of special tissues–*xylem* and *phloem.* Xylem tissue cells carry water from the roots to the leaves. Phloem tissue cells carry sugars made during photosynthesis in the leaves to other parts of the plant. Tracheophytes occur in most parts of the world.

Subdivision Lycophytina

These plants, which include club mosses, iseotopsids, and selaginellas, have leaves with a single central vein. Spores are produced in sporangia that grow in the stem-leaf nodes or on the leaves. The sporangia are distinctly kidney shaped. Plants in this subdivision tend to grow in moist, shady areas.

Class Lycopodiopsida

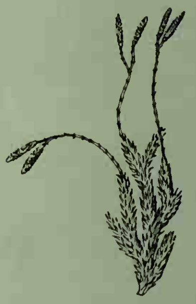
Lycopodiopsids are the club mosses and ground pines. Many species have stems that produce needlelike leaves. Spores are often tightly clustered at the tips of branches. Lycopodiopsids commonly grow on forest floors.

Class Selaginellopsida

Selaginellas produce separate male and female spores. They are leafy and usually delicate in construction. Though most selaginellas live in moist places, one kind, the "resurrection plant," occurs in desert environments.

Class Isoetopsida

Isoetopsids produce two kinds of spores, one male and one female. These small plants have grasslike leaves and live in wet, sometimes flooded places. During the Carboniferous Period, about 360 to 286 million years ago, some isoetopsids were large trees.



Club moss (Lycopodiopsida)

Subdivision Euphyllophytina

Euphyllophytes include most of the vascular plants. Their leaves usually have many veins, and their reproductive organs and internal structures differ from those of the Lycophytina plants.

Class Psilopsida

The plants in this class are called whisk ferns or fork ferns. They have many slender, highly branched aerial stems by which the plants spread. They reproduce from spores. These rare plants are found in tropical and subtropical regions.

Class Sphenopsida

Living sphenopsids are known as horsetails or scouring rushes. They have small leaves that occur in whorls at the nodes on the stem. Stems are hollow except at the nodes, giving them a jointed appearance. They grow 2 to 3 feet (61 to 91 centimeters) tall and reproduce by means of spores. During the Carboniferous Period, sphenopsids made up a much larger group that included trees.

Class Pteridopsida

This class includes the ferns. Most ferns have large leaves called *fronds.* They reproduce by means of spores. Ferns are commonly seen on forest floors, but tropical fern trees may grow more than 65 feet (20 meters) high. Some floating aquatic ferns have leaves only about 1 inch (2.5 centimeters) long. Next to the flowering plants, ferns are the most diverse group in the division Tracheophyta.

Class Gymnospermopsida

Gymnosperms reproduce by means of *naked,* or uncovered, seeds. Many gymnosperms are evergreens with a wide variety of leaf structures. The class consists of conifers, cycads, ginkgoes, and gnetaleans.

Order Coniferales

Most conifers are evergreen trees or shrubs with needlelike or scalelike leaves. Almost all conifers bear their seeds in woody cones.

Order Cycadales

Cycads grow fernlike leaves. Their seeds are borne in large cones. Many species have unbranched, erect stems, while others have partially underground stems called *tubers.* Some cycads are trees.

Order Ginkgoales

Ginkgoes are trees with fan-shaped leaves. They bear fleshy seeds at the end of short branches. The seeds are not in cones. Only one species of ginkgo exists today.

Order Gnetales

Gnetaleans are closely related to flowering plants and share many characteristics with them. Gnetalean seeds are borne in complex cones. Living forms vary widely in appearance and inhabit deserts and tropical rain forests.

Class Anthopsida

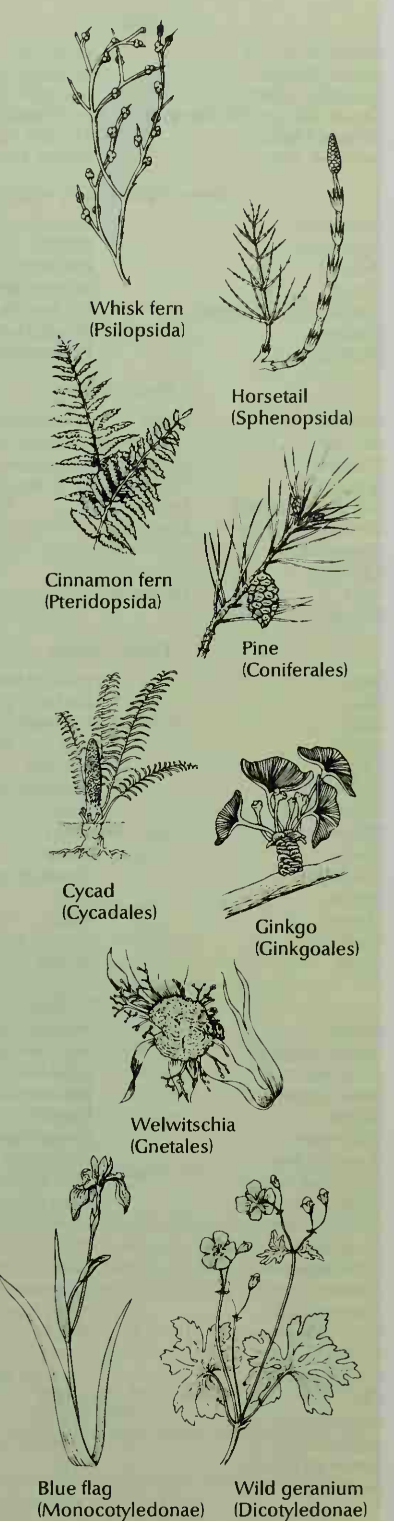
Flowering plants, or angiosperms, make up this class. All angiosperms reproduce by means of covered seeds. They bear their sexual organs in flowers. After fertilization, the ovary grows into a fruit that encloses the seeds. Angiosperms are the most diverse group of plants, growing from the tropics to the polar regions. They are divided into two subclasses–Monocotyledonae and Dicotyledonae.

Subclass Monocotyledonae

Monocots have seeds with only one *cotyledon* (seed leaf). The main veins in the leaves of these plants usually run parallel to each other. Flower parts usually occur in multiples of three.

Subclass Dicotyledonae

Dicots have seeds with two cotyledons. Their leaves have a complex system of veins. Dicot flower parts usually occur in multiples of four or five.



Study aids

Related articles in *World Book* include:

Biographies

Bailey, Liberty H.
Brown, Robert
Burbank, Luther
Carver, George Washington
Darwin, Charles
De Vries, Hugo
Gray, Asa
Lamarck, Chevalier de
Linnaeus, Carolus
McClintock, Barbara
Mendel, Gregor J.
Peattie, Donald Culross

General plant study articles

Adaptation
Agronomy
Biology
Botany
Classification, Scientific
Ecology
Environment
Evolution
Habitat
Heredity
Horticulture
Marine biology
Paleobotany
Paleontology

Kinds of plants

Angiosperm
Annual
Biennial
Bryophyte
Carnivorous plant
Conifer
Dicotyledon
Epiphyte
Fern
Flower
Grass
Gymnosperm
Herb
Hornwort
Legume
Liverwort
Monocotyledon
Moss
Perennial
Poisonous plant
Pteridophyte
Shrub
Succulent
Tree
Vegetable
Vine
Water plant
Weed

Parts of plants

Bark
Bud
Bulb
Catkin
Cell
Cellulose
Chlorophyll
Chloroplast
Corm
Cotyledon
Drupe
Flower
Fruit
Grain
Inflorescence
Leaf
Lenticel
Nut
Raceme
Rhizome
Root
Sap
Seed
Spore
Stem
Thorn
Tuber
Wood

Plant diseases and pests

Aphid
Apple maggot
Army worm
Bean beetle
Blight
Boll weevil
Boxelder bug
Browntail moth
Cankerworm
Codling moth
Corn borer
Corn earworm
Cutworm
Damping-off
Dutch elm disease
Ergot
Fungal disease
Gall
Grain weevil
Gypsy moth
Japanese beetle
Leafhopper
Measuring worm
Mediterranean fruit fly
Mildew
Mosaic disease
Parasite
Peach moth
Phylloxera
Pink bollworm
Potato beetle
Rose chafer
Rot
Rust
San Jose scale
Scale insect
Smut
Tent caterpillar
Tussock moth
Viroid
Weevil
Whitefly
Wilt

Plant products

Alcohol
Charcoal
Cork
Drug
Dye
Fiber
Food
Forest products
Gutta-percha
Lumber
Paper
Perfume
Resin
Rosin
Rubber
Tar
Turpentine

Plant growing

Agriculture
Alternation of generations
Auxin
Bonsai
Breeding
Farm and farming
Fertilizer
Gardening
Germination
Grafting
Greenhouse
Herbarium
Hybrid
Hydroponics
Insecticide
Nursery
Pest control
Photoperiodism
Photosynthesis
Pollen
Pruning
Reproduction
Soil
Terrarium
Transplanting

Where plants live

Bog
Desert
Forest
Grassland
Pampa
Plain
Pond
Prairie
Rain forest
Savanna
Seashore
Steppe
Tundra
Wetland

Plant life maps

See the plant life maps with the following articles:

Africa
Asia
Australia
Europe
North America
South America

Articles on individual plants

World Book has hundreds of separate articles on specific plants. Some of the most common are listed here:

Major crops

Alfalfa
Barley
Corn
Cotton
Oats
Peanut
Potato
Rice
Rye
Soybean
Sugar beet
Sugar cane
Tobacco
Wheat

Garden flowers

Aster
Baby's-breath
Bachelor's-button
Belladonna
Bleeding heart
Canna
Chrysanthemum
Cineraria
Cosmos
Crocus
Daffodil
Dahlia
Day lily
Easter lily
Flowering tobacco
Forget-me-not
Four-o'clock
Fuchsia
Geranium
Gladiolus
Hollyhock
Ice plant
Impatiens
Iris
Larkspur
Lily
Lily of the valley
Marigold
Mignonette
Morning-glory
Nasturtium
Oxalis
Pansy
Peony
Petunia
Phlox
Pimpernel
Pink
Poppy
Primrose
Rose
Salvia
Sand verbena
Saxifrage
Sego lily
Snapdragon
Statice
Stock
Sunflower
Sweet alyssum
Sweet pea
Sweet William
Tiger lily
Tulip
Verbena
Zinnia

Wildflowers

Adonis
Anthurium
Arbutus
Bellflower
Black-eyed Susan
Blazing star

odroot
ebonnet
et
ttercup
la
ckscomb
lumbine
wslip
isy
Dandelion
Devil's paintbrush
Fireweed
Gentian
Goldenrod
Hepatica
Indian paintbrush
Jack-in-the-pulpit
Lupine
Oregon grape
Ramp
Soap plant
Spring-beauty
Toadflax
Trillium
Violet
Wormwood

Herbs

m
sil
ters
neset
iendula
lla
raway
tnip
neraria
riander
min
campane
nnel
wort family
nseng
rehound
rseradish
vender
orice
Marjoram
Mint
Parsley
Pennyroyal
Peppermint
Portulaca
Psyllium
Quinoa
Rosemary
Saffron
Sage
Spearmint
Spikenard
Sweet cicely
Tansy
Telegraph plant
Thyme
Valerian
Vanilla

Vegetables

For a list of separate articles on vegetables, see the *Related ticles* at the end of the Vegetable article.

Shrubs

anthus
alea
yberry
ach plum
gonia
ugainvillea
x
idal wreath
oom
ckthorn
ffaloberry
scara sagrada
ssava
aparral
ral tree
ogwood
lantine
rsythia
rze
uayule
awthorn
Hydrangea
Hyssop
Jojoba
Lilac
Magnolia
Manzanita
Mock orange
Oleander
Plumbago
Privet
Protea
Pussy willow
Rhododendron
Saint-John's-wort
Silverbell
Snowball
Spiraea
Sumac
Wax myrtle
Winterberry
Yucca

Trees

For a list of separate articles on trees, see the *Related articles* the end of the Tree article.

Other related articles

alance of nature
iodiversity
iological clock
ome
otanical garden
onservation
Endangered species
Flavonoid
Fossil
Invasive species
Nature study
Nitrogen cycle
Petrified forest
Plant quarantine

Outline

I. The importance of plants
A. Food
B. Raw materials
C. Medicines
D. Plants and the cycle of nature

II. Kinds of plants
A. Seed plants
B. Ferns
C. Lycopsids
D. Horsetails
E. Bryophytes

III. Where plants live
A. The tundra
B. Forests
C. Chaparrals
D. Grasslands
E. Savannas
F. Deserts
G. Aquatic regions

IV. Parts of plants
A. Roots
B. Stems
C. Leaves
D. Flowers
E. Seeds

V. How plants reproduce
A. Sexual reproduction
B. Vegetative propagation

VI. How plants grow
A. Germination
B. Water movement
C. Photosynthesis
D. Respiration
E. Factors affecting plant growth

VII. How plants change
A. Early plants
B. Water storage
C. Seed dispersal
D. Insect-eating plants
E. How people have changed plants

VIII. Plant enemies
A. Diseases
B. Nutrient deficiencies
C. Pests
D. How plants protect themselves
E. Control of diseases and pests

IX. Classification of plants

Questions

About how many kinds of plants are there?
How do animals help distribute seeds?
What are the four main parts of most flowering plants?
When did plants first appear on the land?
Describe the role of plants in the cycle of nature.
Why are flowering plants called *angiosperms*?
What is *cross-pollination*? What is *self-pollination*?
How do green plants make their own food?
What are the three major types of forests?
What are *carnivorous* plants?

Additional resources

Level I
Dow, Lesley. *Incredible Plants.* Time-Life Bks., 1997.
Hershey, David R. *Plant Biology Science Projects.* Wiley, 1995.
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Silverstein, Alvin, Robert, and Virginia. *Plants.* 21st Century Bks., 1996.
Taylor, Barbara. *Incredible Plants.* D K Pub., 1997.

Level II
Attenborough, David. *The Private Life of Plants: A Natural History of Plant Behavior.* Princeton, 1995.
King, John. *Reaching for the Sun: How Plants Work.* Cambridge, 1997.
Mabberley, D. J. *The Plant-Book: A Portable Dictionary of the Vascular Plants.* 2nd ed. Cambridge, 1997.
Stearn, William T. *Stearn's Dictionary of Plant Names for Gardeners.* Cassell, 1996.
Stern, Kingsley R. *Introductory Plant Biology.* 7th ed. W. C. Brown, 1997.

Plant, Aquatic. See Water plant.

Plant breeding. See Breeding.

Plant quarantine laws regulate the movement both of plants and of other materials that may carry a plant disease or insect pest. The reason for the quarantine is to keep the disease or insect from spreading from infested areas. Some plant quarantine laws list plants that may not be shipped in and out of a locality. Such laws may also give directions for moving, packing, and labeling.

In a quarantine, officials may examine all plants at the border of the quarantined area and keep out the dangerous types. Other laws merely require an inspection of the plants or the place where they were grown.

Foreign plant quarantines control the shipping of plants from other countries. Such quarantines include those intended to keep out citrus canker disease, the Mediterranean fruit fly, and the khapra beetle. Domestic quarantines control plant movements from place to place within the country. They protect against stem rust, the gypsy moth, the Japanese beetle, the pink bollworm, and the white-fringed beetle.

In the United States, local, state, and federal governments may quarantine plants. The Animal and Plant Health Inspection Service helps enforce quarantines of plants that may carry diseases or insect pests.

Critically reviewed by the Animal and Plant Health Inspection Service

See also **Insect** (Insect control).

Plantagenet, *plan TAJ uh niht,* was the family name of a line of kings that ruled England from 1154 to 1399. These kings descended from the marriage of Matilda, daughter of King Henry I, to Geoffrey, count of Anjou, France. Geoffrey was nicknamed *Plantagenet* because he wore a sprig of the broom *(genet)* plant in his cap. Numerous historians also call these kings *Angevins,* meaning *from Anjou.*

The Plantagenet dynasty began with Henry II, son of Matilda and Geoffrey. Henry ruled from 1154 to 1189 over England and vast possessions in France. He centralized the English government, established peace and order, and founded the English common law system. His son Richard the Lion-Hearted led the Third Crusade and ruled from 1189 to 1199. Richard's brother John succeeded him and ruled from 1199 to 1216. John lost most of England's French possessions. He was forced to grant Magna Carta in 1215 (see **Magna Carta**).

John's son Henry III ruled ineffectively from 1216 to 1272. Henry's son, Edward I, ruled from 1272 to 1307. He conquered Wales, invaded Scotland and proclaimed himself its king, and improved the English government and legal system. Edward's son Edward II lost Scotland. In 1327, he was forced by some of England's nobles to give up his throne and then was murdered. His son Edward III ruled from 1327 to 1377 and began the Hundred Years' War with France.

After Edward III's grandson Richard II was deposed in 1399, the Plantagenets split into the houses of Lancaster and York. These two houses then ruled England until 1485 (see **Lancaster; York**). Bryce Lyon

See also the separate biographies in *World Book* for each ruler mentioned in this article, such as **Henry II** (of England).

Plantain, *PLAN tuhn,* is the common name of a group of low-growing herbs, several of which are common weeds. The *common plantain,* also called the *broadleaf plantain,* is a species that often troubles gardeners. It may be recognized in spring by its circular cluster of broad light-green leaves that grow from the roots. Tall, slender spikes grow up from the center of the cluster. In the summer, these spikes are thickly covered with tiny green flowers. Other plantains include the *narrow-leaf plantain,* also known as *rib grass,* which has narrow leaves and short, thick spikes; and the *seaside plantain,* which has leaves that are used in medicine to lessen inflammation. The seeds of various types of plantains are used as a mild laxative.



WORLD BOOK illustration by Lorraine Epstein

Common plantain

A tropical plant called the plantain is a kind of banana. The fruit of this plant looks much like the banana, although it is hard and starchy and is eaten cooked. The plantain's fruit has become one of the chief foods in tropical countries. A type of flour is made from the fruit of the plantain. See **Banana**. Anton A. Reznicek

Scientific classification. Plantains belong to the plantain family, Plantaginaceae. The scientific name for the broad-leaf plantain is *Plantago major.* The narrow-leaf is *P. lanceolata.* The seaside plantain is *P. maritima.*

Plantation is a large land area where workers usually grow a single crop. The most common crops that are grown on plantations are cocoa, coffee, rice, rubber, sugar cane, bananas, pineapple, and other kinds of tropical fruit. Most plantations are located in rich, level land areas in the tropical and subtropical regions of the world.

Plantations vary widely, depending largely upon their stage in development. Three separate types of plantations may be characterized as those that use slave labor, "free" labor, and skilled labor.

Slave-labor plantations were established by western Europeans in the colonies they established throughout the world. The Europeans furnished money and management for plantation development and also the market for what was produced. Most of the plantation workers were slaves or *indentured servants* who were bound by contract to serve a landowner. They usually worked long hours in large gangs. They received few of the comforts of life. Plantation owners were the ruling class in society. These landowners operated the plantations with slave labor in various parts of America from the colonial period until slavery was abolished in 1865. After that date, plantations operated with the use of free labor.

"Free"-labor plantations came into use when slavery fell into disrepute. These large farming units produced single crops and paid low wages to hired hands. Laborers who worked for wages and *sharecroppers* (farmers who worked for a share of the crop) did most of the work. Various degrees of semislavery developed, including *peonage.* Peons are forced to work to pay off debts. Sharecroppers received a share of the crop from

tl land on which they normally did all the work. Wage l:orers worked in gangs and received wages. Wage la-b·ers, peons, and sharecroppers frequently had an o:n account at the plantation *commissary* (supply s re). The commissary often charged high prices. As a r ult, the workers would become indebted to the c ner and would be forced to work off their debts. S:h plantations still exist in parts of the world, and the p ople who own them form the ruling class.

Skilled-labor plantations are now developing in r ny areas. Sharecroppers and wage hands are disap-p aring. Since World War II (1939-1945), plantation agri-c ture has changed rapidly. Machines and skilled work-e are now being used instead of mule power and h d labor. Laborers receive higher wages and live bet-t than plantation workers did in earlier days. Planta-t ns no longer use gangs of slaves or peons. A more mocratic society has replaced the rule by plantation ners. In many areas, plantations are being broken up, d the land is being distributed among the former ntation workers. James D. Arnold

See also **Colonial life in America** (Development of t: Thirteen Colonies [picture]); **Mississippi** (Places to it); **United States, History of the** (picture: Cotton plan-tions).

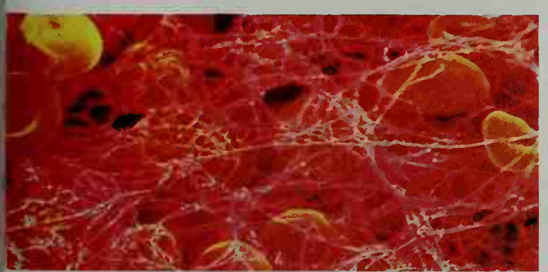
anting. See **Farm and farming; Tree** (pictures: How plant a tree).

aque. See **Teeth** (Cleaning the teeth; Periodontal dis-ses).

asma, *PLAZ muh,* is the liquid portion of blood. This llowish, transparent fluid makes up more than half the lume of blood in the human body. The solid parts of ood—the red and white blood cells and the platelets—e suspended in the plasma. Plasma consists of more an 90 percent water. A variety of dissolved substances, cluding proteins, salts, digested foods, and wastes, ake up the rest of the plasma.

Functions of plasma. Plasma makes the blood fluid. ithout this characteristic, blood could not perform its b of transporting vital substances throughout the dy. Plasma carries blood cells and platelets to all parts the body. It also transports digested foods to the dy tissues. It picks up soluble waste materials from e tissues and carries them to the kidneys for excretion om the body. Plasma also transports hormones that lp control the function and development of many rts of the body.

The three major types of plasma proteins—*albumin, obulins,* and *fibrinogen*—each serve important func-



CNRI, Science Photo Library

he plasma protein fibrinogen promotes clotting. When a ood vessel is injured, fibrinogen forms sticky threads, *above,* hich hold cells together to prevent excessive blood loss.



Art Glauberman, Photo Researchers

Plasma is separated from whole blood by rotating bags of blood in a centrifuge. Then a laboratory technician, *above,* filters and separates the yellow plasma from the red blood.

tions. Albumin helps maintain a balance between the amount of fluid that leaves and enters the blood vessels. If plasma does not have enough albumin, excessive fluid passes through the blood vessels and accumulates in the tissues, causing the body to swell. In addition, albumin binds and carries nutrients absorbed from the digestive system.

The globulins—particularly the *gamma globulins*—help protect the body from disease. Gamma globulins are *antibodies,* disease-fighting proteins that attack bacteria, viruses, poisons, and other harmful substances (see **Immune system**).

Fibrinogen is the most abundant of a group of plasma proteins called *clotting factors.* These proteins prevent excessive loss of blood from injured vessels. When a person starts bleeding, a chain reaction involving the clotting factors takes place. This reaction results in the formation of a blood clot.

Uses in medicine. Physicians use plasma for transfusions to provide clotting factors and other proteins. Plasma transfusions are used chiefly in the treatment of bleeding disorders. Because it contains most of the clotting factors, a transfusion of plasma can halt bleeding in many such cases. Plasma transfusions are also used to treat severe blood loss when whole blood is unavailable. Such transfusions have saved the lives of millions of soldiers injured in battle.

Blood banks obtain proteins from plasma through a process called *fractionation.* Proteins obtained in this way include gamma globulins and individual clotting factors. Doctors sometimes use gamma globulins to protect against or modify such infectious diseases as measles and viral hepatitis. They use an individual clotting factor to control *hemophilia,* a bleeding disorder caused by inherited deficiency or abnormality of a certain clotting factor.

Blood banks separate plasma from whole blood by allowing the solid components to settle by gravity or by using a machine called a *centrifuge.* A special donation

technique called *plasmapheresis* removes only plasma, returning the blood cells and platelets to the donor. Blood banks freeze plasma intended for use in transfusions. Plasma intended for fractionation is sent to various companies for processing. G. David Roodman

See also **Blood; Blood transfusion; Serum.**

Plasma, *PLAZ muh,* in physics, is a form of matter composed of electrically charged atomic particles. The sun and the other stars, and most of the other objects in space, consist of plasma. Lightning bolts also consist of plasma, but few other plasmas occur naturally on the earth.

Artificially created plasmas have many practical uses. For example, electricity turns the gas in the tube of a neon sign into a plasma that gives off light. A welding process called *arc welding* uses electricity to produce the high temperatures needed to join pieces of metal. Electric rockets may someday use plasma fuels for long trips through space.

A plasma can be made by heating a gas or by passing an electric current through it. A gas consists of atoms or molecules. Each atom has a nucleus surrounded by one or more negatively charged particles called electrons. Great heat or a flow of electricity *ionizes* an atom by stripping off one or more of its electrons. These electrons then move around independently. An atom or molecule that loses electrons has a positive charge and is called an *ion.* As the temperature increases, more and more atoms in a plasma become ionized.

The physical and electrical qualities of a gas change greatly when it becomes a plasma because the ions and electrons in the plasma are separated. For example, most gases conduct electricity poorly and are not affected by magnetic fields. A plasma, on the other hand, conducts electricity well and is affected by magnetic fields. Gases consist of atoms that move around independently and in no definite way. The electrons and ions in a plasma may move around in groups, usually in wavelike motions. Plasmas have qualities unlike those of the three basic forms of matter—gases, liquids, and solids. For this reason, physicists consider plasma a fourth state of matter.

Scientists hope someday to generate electricity by using plasmas to control the process of *nuclear fusion.* Nuclear fusion gives off tremendous amounts of energy when two lightweight atomic nuclei unite to form a heavier nucleus. The energy from controlled fusion could be used as heat to make steam for electric generators. But temperatures of up to 100,000,000° C are required to make the atomic nuclei react. Such a high temperature would melt any container. Many physicists are attempting to produce controlled fusion with hot plasmas held in place by strong magnetic fields or by some other method that does not involve use of a material container. Francis T. Cole

See also **Nuclear energy** (Nuclear fusion); **Rocket** (Electric rockets); **Welding** (Arc welding).

Plaster is a mortar coating that is applied to wall surfaces and ceilings of buildings to make them more airtight and to provide a finished surface. Plastering is putting the plaster on these walls. Certain types of plaster are called *stucco.* Stucco is often used on the outer walls of houses.

Plaster is commonly made of sand and a cementing agent, such as gypsum, lime, or portland cement. The ingredients are mixed with water. Hair or fiber is mixed with the first and second coats to strengthen the plaster. The hair is goat or cattle hair, and the fiber is Manila, jute, or wood fiber.

Lightweight materials such as *perlite* or *vermiculite* may be used instead of sand. These materials absorb sound and are fire resistant.

Plaster bases. Plaster can be put directly on a masonry wall, but it cannot be put directly on a solid wood wall. The surfaces to which plaster can be applied are called plaster bases. Bases may be of various kinds of building blocks, or brick or stone. Bases may also be made with *laths.* Laths are metal sheets, pieces of gypsum or fiberboard, or wooden strips that are put on the surface to be plastered to provide a better grip.

Wood laths are laid parallel, with narrow spaces between them. The plaster enters the spaces and forms wedges, called *keys.* The wedges hold the plaster to the laths. In most modern buildings, gypsum board or metal laths are used. Metal laths are metal sheets about 2 feet (0.6 meter) wide and 8 feet (2.4 meters) long. Open spaces in the sheets allow plaster to penetrate and obtain a firm grip. Gypsum board has a gypsum plaster core between surfaces of heavy paper. The paper and core are pressed together to form a plastering surface.

Plastering. The plaster is put on the plaster base with a special tool called a *trowel.* It is smoothed with a tool called a *darby* and may be made more even with a long straightedge called a *rod.* Wood or metal strips, called *grounds,* are placed around openings and along the top of the baseboard as guides for finishing the plastering. If the plastered wall is large, plaster guides called *screeds* are made on the *scratch* (first) coat. Three coats of plaster should be used on wood or metal lath. But only two coats are needed on a brick or tile surface.



WORLD BOOK photo by Dan Miller

A plasterer applies the mortar coating in two or three coats to finish off the inside walls and ceilings of buildings.

lastering tools







Trowel for final smoothing of plaster

Hawk, on which mortar is held

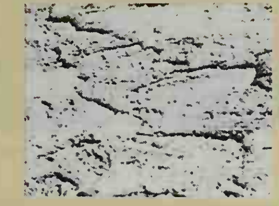
Float, for smoothing mortar

astering tools, *above,* include the trowel, hawk, and float. ie finished wall surfaces, *below,* show two plaster textures.

From *Plasterers' Manual,* Courtesy Portland Cement Assn.



Modern American



English cottage

The surface finish of the plaster may be a *white coat* lime putty, which has a thick, puttylike consistency ıen applied. Gypsum *gauging plaster* is added to the tty coat to reduce shrinkage and thus avoid cracking. e material is formed into a smooth finish with a steel ›wel. The sand-float finish is a rough finish that is ıde by going over the last coat of gypsum plaster and nd with a special kind of wood or cork trowel, called a *›at.* The sand-float finish looks like rough sandpaper. ›ecial plasters may be applied in different ways to look e natural stones. The most common of these are *agliola,* which is an imitation marble; imitation *caen* ›ne; and imitation *travertine* stone. Paul Bianchina

See also **Building trade** (Career opportunities); **Ce-ent and concrete; Plaster of Paris.**

aster of Paris is a white powder that, when mixed th water to form a paste, will turn hard in a few min-es. This substance is used for casting small statues, for aking models and molds, for surgical casts, and for her purposes. It is made by heating gypsum, a mineral ›mposed of calcium sulfate and water. When the water partly driven off, the gypsum softens and is easily ushed to form a powder. When water is added again, e mass hardens to a stonelike substance.

James S. Reed

lastic explosive is a puttylike explosive that can be olded into any shape. Plastic explosive is made of a *asticizer* (a substance that makes the explosive flexible) ıd either a mixture of two explosive substances called *›X* and *PETN* or RDX alone. Only a powerful *detonator* capsule containing an easily explodable charge) can ›t off a plastic explosive.

The United States Army developed plastic explosives ıring World War II (1939-1945). The explosives became mous in the early 1960's when a French terrorist ›oup, the Secret Army Organization (OAS), used them try to prevent Algeria from becoming independent. astic explosives have remained a popular weapon nong terrorists because they are powerful, easily hid-›n, and difficult to detect. Frances M. Lussier

See also **Explosive** (High explosives).

lastic surgery is a field of medicine that specializes in the repair or reshaping of defects of the body. It also may involve the repair of muscles, bones, blood vessels, and nerves. The word *plastic* comes from a Greek word meaning *to shape* or *mold.* Plastic surgeons shape and mold body tissues. They rearrange, remove, or replace tissue to restore normal function to deformed or damaged body parts. Plastic surgeons also attempt to improve the appearance of aging tissue or of unattractive body parts.

Methods of plastic surgery include *grafting* (transferring tissue), repairing or reshaping tissue structures, removing tissue, and, less frequently, replacing tissue with an artificial substance. In grafting, a plastic surgeon replaces damaged tissue with healthy tissue from another area of the body. The surgeon may graft a single tissue—such as skin, a nerve, or bone—or a combination of tissues. In some cases, the surgeon must reconnect the transferred tissue to the circulatory system. Otherwise, blood will not circulate through the tissue adequately and the tissue will die. Grafting is used in treating such cases as severe burns, gunshot wounds, and injuries resulting from automobile accidents.

Injuries or diseases involving the loss of tissue or of a body part require the rebuilding or reshaping of tissue structures. Under the appropriate circumstances, plastic surgeons may be able to reattach a severed body part. Often, however, the severed part is too severely damaged or has been without blood circulation for too long to permit repair. Congenital deformities, such as cleft lip, cleft palate, and birth defects of the face, ears, hands, and genitals, can be corrected by rebuilding and reshaping tissues. Similarly, a deformed or unattractive nose can be reconstructed and reshaped by a plastic surgeon in an operation called a *rhinoplasty.*

Some plastic surgery done for cosmetic reasons involves the removal of tissue. A facelift operation, also known as a *rhytidectomy,* gives the patient a more youthful appearance by removing excess or aged facial skin. Plastic surgeons use a technique called *liposuction* to remove excess fat from such areas as hips, thighs, and ankles. In this procedure, an incision is made in the skin and then fat is suctioned out through a tube.

Plastic surgeons can reconstruct or alter the size or shape of a woman's breasts. This type of operation is called a *mammoplasty.* In a mammoplasty, the surgeon inserts a synthetic implant into one or both breasts.

Qualifications for a plastic surgeon include a longer *residency* (period of training) than that of some other medical specialists. In the United States, plastic surgeons are certified by the American Board of Plastic Surgery. To be eligible for certification, a person must graduate from an accredited medical school and then serve at least three years of residency in general surgery and an additional two years of residency in plastic surgery. The person then must pass a written and oral examination prepared by the board.

A plastic surgeon's credentials can be verified by checking with a local medical society or with the American Board of Plastic Surgery in Philadelphia. Names of local plastic surgeons can be obtained from the American Society of Plastic and Reconstructive Surgeons Executive Office in Arlington Heights, Ill.

William P. Graham III

See also **Skin grafting.**





Pontiac Division, GMC

Strong, lightweight plastics make up the body of this van.



Amoco Chemical Company

Durable polyester fabrics are made of plastic fibers.

WORLD BOOK photo by Ralph J. Brunke

Plastics are used to package a variety of items.

Plastics have special properties that allow them to be used in a wide variety of products. The photographs above illustrate some of the many uses of plastics.

Plastics

Plastics are man-made materials that can be shaped into almost any form. They are one of the most useful materials ever created. Our homes, schools, and businesses are filled with plastic products. Engineers have developed plastics that are as rigid as steel or as soft as cotton. They can make plastics that are any color of the rainbow—or as clear and colorless as crystal. Plastics can be rubbery or rigid, and they can be shaped into an endless variety of objects, ranging from automobile fenders to squeezable bottles to soft fabrics. Plastic products, especially those used by industries, often have a useful life of many years.

Plastics consist of long chains of molecules called *polymers.* These chains are made of repeating patterns of smaller molecules. Each of the smaller molecules forms a "link" in the polymer's chain. In some plastics, the chains are rigid and are lined up like logs flowing down a river. In others, they are flexible and tangled like spaghetti on a plate. These different structures give plastics their most notable characteristic, the ability to be shaped. In fact, the word *plastics* comes from the Greek word *plastikos,* which means *able to be shaped.*

As useful as they are, plastics do have drawbacks. The biggest problem is that most plastics take a very long time to *decompose* (break down into simple compounds). Figuring out how to dispose of plastic wastes has become a major environmental concern.

The contributors of this article are all members of the staff of the Polymer Processing Institute (PPI) at Stevens Institute of Technology. They are Joseph A. Biesenberger, President of PPI and Professor of Chemical Engineering; Paul G. Kelleher, Associate Manager of PPI's New Jersey Polymer Extension Center; and Marino Xanthos, Research Director of PPI and Research Professor of Chemical Engineering.

How plastics are used

Engineers have created hundreds of different plastics, each with its own properties. They have developed plastics that can replace metals, natural fibers, paper, wood and stone, and glass and ceramics. Manufacturers use these plastics to make products stronger, lighter, longer lasting, easier to maintain, or less expensive to make. In addition, inventors have used plastics to create items that could be made with no other materials.

To replace metals. Plastics are used to replace met- in a variety of products. Automakers commonly use astic bumpers, fenders, and wheel covers in their oducts. In some cars, the entire body is made of plas- s. Plastic auto parts do not rust, nor do they dent as sily as metal ones. Plastic auto parts are easier and of- n less expensive to repair. Replacing metal parts with astic ones also reduces the weight of a vehicle, result- g in more efficient fuel use. Airplane manufacturers e plastic wing and body assemblies for many of these me reasons. These large, seamless parts also create s wind resistance than do riveted metal sections.

Plastics have also replaced metals in many building nstruction materials, such as pipe and home siding. astic siding does not dent as easily as that made from uminum. Pipe made from plastics is lightweight and sy to cut and join. Moreover, it does not corrode like etal pipe.

Surgeons mend broken bones with plastic parts her than metal ones, because the plastics are less ely to trigger a harmful reaction. Dentists often use astic fillings because—unlike metal fillings—the plastic es can match the patient's tooth color.

To replace natural fibers and hides. The textile in- stry uses plastics to replace such natural fibers as cot- n, ramie, silk, and wool. Plastic fibers may have such alities as strength, durability, and resistance to stains d wrinkling. Some plastic fibers are tough enough to used for automobile safety belts or bulletproof vests. hers are delicate enough to be made into sheer siery. Durability and resistance to stains and attack by oths make plastic fibers an excellent material for cloth- g, carpeting, and furniture coverings. Manufacturers n also treat plastic fibers to make them more difficult burn. Plastic fibers are often mixed with natural fibers produce fabrics with qualities similar to an all-natural bric but with added durability.

Plastics are also used to create synthetic leathers, edes, and furs. Spun plastic fibers replace down or athers in insulated jackets and pillows.

To replace paper. Plastics have replaced paper in any packaging applications. Plastic-foam packing ma- rials provide more protection for boxed products than ushed paper does. Many products, particularly deli- te electronic equipment, are packed in foamed plastic serts that fit the shape of the item exactly. Such hard- are items as nuts and bolts are packaged in clear plas- boxes that enable a buyer to see the product.

Plastic wraps have many uses. They preserve foods nger than paper wraps can. Plastic wrap can stretch to rm a seal around the opening of a container. Many ms sold in stores, including board games and com- ct discs, are sealed in clear plastic wrap.

To replace wood and stone. Plastics have replaced ood and stone in many applications. Laminated plastic untertops come in a variety of patterns. Some look e marble. Laminated countertops are lighter, less ex- nsive, and easier to install than marble ones. They so resist marring and stains.

Furniture makers use plastics to produce cabinet ors and tabletops that look like wood but are easier clean and do not warp. Plastics have also replaced ood in boat hulls. Plastic boats are stronger than ooden ones and require less maintenance. Unlike wooden hulls, plastic hulls can be constructed easily in one piece. These smooth, one-piece hulls can be shaped to cut through water with less resistance.

To replace glass and ceramics. Because they are lighter and much less likely to break, plastics have replaced glass or ceramics in a variety of products. Plastic wall tiles, bathtubs, and sinks are cheaper and easier to install than ceramic ones. Airplane windows made of acrylic plastics are lighter and less brittle than glass. Safety and comfort have made lightweight, shatterproof plastic eyeglass lenses a popular substitute for glass lenses. Plastic bottles are also shatterproof, and they have replaced glass ones in packaging such products as milk, ketchup, household cleaners, and many other goods. Plastic bottles also weigh much less than glass ones and so help reduce shipping costs.

To provide new characteristics. Plastics are used in many ways that would not be possible for other materials. They have many medical applications because they are not harmful to the body and can be formed into any shape. Parts made from plastics can replace damaged hip, knee, and finger joints. Plastic pieces are used to rebuild facial structures damaged by accidents. Sometimes, plastic parts are used to replace faulty heart valves and damaged arteries.

Plastics are also used to make insulating foam that blocks the flow of heat and sound. The foam can be blown into the walls of a home through a small hole. Integrated circuits, which hold thousands of transistors that control the flow of electric current, are sealed in plastics. The plastics protect the delicate transistors without interrupting the flow of electric current.

Types of plastics

Although there are hundreds of different plastics, all of them belong to one of two basic types, based on how they behave when heated. These types are (1) thermosetting plastics and (2) thermoplastics.

Thermosetting plastics—or thermosets, for short—can be heated and set only once. They cannot be remelted or reshaped. When a thermoset is heated, it undergoes a chemical reaction called *cross-linking,* which binds its polymer chains together. This reaction is similar to the hardening of an egg when it is boiled. Once it has hardened, it cannot become a liquid again. Because thermosets cannot be remelted, engineers use them in applications that require high resistance to heat. Products made from thermosetting plastics include pot handles, trays for sterilizing medical instruments, and parts for airplanes and spacecraft.

Thermoplastics can be melted and re-formed again and again. Their polymer chains do not form cross-links. Thus, the chains can move freely each time the plastics material is heated.

Thermoplastics are used much more widely than are thermosets. Manufacturers prefer thermoplastics because they are easier to handle. They also require less time to set—as little as 10 seconds, compared to as long as 5 minutes for thermosets. And unlike thermosets, most thermoplastics can be dispersed in liquids to produce durable, high-gloss paints and lacquers. Because their molecules can slide slowly past one another, some thermoplastics tend to lose their shape when exposed to constant pressure over a long period of time. For this

Kinds of plastics

All plastics are classified as *thermosetting* or *thermoplastic,* depending on the way they act when heated. This table lists some common thermosetting and thermoplastic materials according to their chemical names. Each kind includes hundreds of compounds formed by adding chemicals to the basic material.

Thermosetting materials
Allylic: strong, resists heat and weather. Used for electronics parts, coatings for moisture protection.
Epoxy: resists water and weather, hardens quickly, has high bonding strength. Used for adhesives, casting compounds, reinforced plastics, protective coatings, tools.
Melamine- and urea-formaldehyde: easily colored, resists heat, odorless, tasteless. Used for dinnerware, lampshades, adhesives, buttons, tabletops, electrical parts, plywood binders.
Phenolic: resists heat and cold. Used for adhesives, appliance handles, electrical devices, surface coatings.
Polyurethane: tough, resists chemicals. Used for electrical insulation, structural parts, insulation foam, foam seat cushions, fabrics with elastic qualities.
Silicone: resists weather, has high elasticity and good electrical qualities. Used for oven gaskets, electrical insulation, greases and other lubricants, waterproof materials.
Unsaturated polyester: strong, hardens quickly, molds under low pressure. Used for automobile parts, boats, bowling balls.

Thermoplastic materials
ABS (acrylonitrile-butadiene-styrene): strong, long wearing, resists stains and chemicals. Used for telephones, automobile wheel covers, handles, appliance parts, luggage, piping.
Acetal: tough, stiff, keeps its shape under pressure, has high melting point. Used for refrigerator and washing machine parts, cams, wheels.
Acrylic: resists weather and chemicals, easily colored, has high clarity. Used for optical lenses, airplane canopies, signs, displays, automobile tail lights, fabrics, paints.
Cellulose acetate: tough, transparent. Used for toys, novelties, handles, packaging, photographic film, machine guards.
Cellulose acetate butyrate: tough, resists water. Used for steering wheels, pipe, tool handles, industrial parts.
Nylon: strong, springy, resists abrasion, has good electrical qualities. Used for fabrics, gears, bearings, hardware, brush bristles, electrical appliances, carpeting.
Polycarbonate (a polyester): resists heat, has high impact strength. Used for business machine parts, electrical connectors, coil forms, light diffusers, windows, eyeglass safety lenses, airplane canopies.
Polyethylene: lightweight, flexible, has waxlike feel. Used for bottles, packaging, electrical insulation.
Polyethylene terephthalate (a polyester): strong, flexible, resists water and chemicals. Used for magnetic tapes, plastic soft drink bottles, decorative films.
Polypropylene: lightweight, resists heat and chemicals. Used for rope, packaging, automobile parts, baby bottles, appliance parts, carpeting.
Polystyrene: lightweight, tasteless, odorless. Used for housewares, toys, electrical insulation, radio cabinets, packaging.
Polytetrafluoroethylene: resists heat and chemicals, slides easily. Used for cable insulation, bearings, valve seats, gaskets, frypan coatings, slides and cams.
Polyvinyl chloride: strong, easily colored, rigid or flexible, resists abrasion. Used for imitation leather, packaging, pipe, electrical insulation, flooring.
Polyvinylidene chloride: crystal clear, tough. Used for packages for meat and other foods.

reason, manufacturers prefer to use thermosets for such products as plastic seats on buses.

How plastics are made

The substances used to make plastic products are called *synthetic resins.* These resins are made primarily from petroleum, but some come from such other natural sources as coal, natural gas, cotton, and wood. Chemical manufacturers produce the resins and sell them to companies that make plastic products.

The chemistry of plastics. To understand how plastics are made, it is helpful to know something about the chemistry of polymers. The polymers in plastics are made up of small molecules called *monomers.* Most of these molecules are composed of carbon, hydrogen, nitrogen, and oxygen atoms. Some include chlorine, fluorine, silicon, or sulfur atoms. A polymer chain consists of hundreds, thousands, or even millions of monomer links. In some polymers, these links are made up of one kind of monomer, repeated over and over. In other polymers, the chains are composed of two or more kinds of monomers, which may be linked randomly or in alternating sequences. In some polymers, blocks of one kind of monomer are joined to blocks of another kind.

Polymer chains may or may not have branches. A chain may have branches on only one side or alternating from one side to the other. The chains may pack together in straight rows to make a stiff, crystalline solid. Or they may remain tangled and spread out, to make a soft, rubbery material. The properties of plastics depend on the types of monomers in their polymer chains, the lengths of the chains, and the arrangement of the chains.

Different kinds of polymer molecules can be mixed together to form *polymeric alloys,* or *blends.* Alloys are often easier to create than new synthetic polymers. They may have properties that lie between those of their component polymers, or they may have properties that are better than either. Polymer scientists can engineer plastics blends with the ideal properties for nearly every task. Alloys are used in products that range from packaging films to automobile body parts.

Making synthetic resins. Resin manufacturers make polymers by combining chemical compounds. These range from familiar chemicals, such as ammonia and benzene, to compounds with tongue-twisting names, such as hexamethylenediamine. When a manufacturer combines appropriate compounds, chemical reactions cause atoms to cluster together to form monomers. Further reactions cause the monomers to *polymerize*—that is, to form long chains of molecules. Polymerization produces the synthetic resin.

The steps in polymer building can be illustrated by the production of polystyrene resin. To make polystyrene, a chemical manufacturer begins with the liquid benzene and the gas ethylene, two chemicals derived from petroleum. The manufacturer bubbles the ethylene through the benzene. During this process, the compounds react to form the liquid *ethylbenzene.* Ethylbenzene is used to make liquid styrene by heating ethylbenzene gas to a high temperature and bringing it into contact with certain metal oxides. This process removes some hydrogen atoms from the ethylbenzene. The remaining atoms form molecules of styrene.

Finally, the manufacturer polymerizes the styrene to make solid polystyrene. One way this can be done is by suspending the styrene in water, adding chemicals, and heating it. A chemical reaction causes the styrene molecules to link together and form chainlike molecules of polystyrene. The manufacturer then forms the solid

p ystyrene into grainlike particles. These particles are tl raw material used to mold polystyrene products.

Vlanufacturers frequently use *additives* to change the p operties of a plastics resin. Common additives include (reinforcements, (2) fillers, (3) plasticizers, and (4) pig-n nts.

Resin makers use such reinforcements as glass fibers c carbon fibers to give plastics extra strength or rigidi-t The resulting mix, called a *composite* or a *reinforced p stic,* may contain from 10 to as much as 80 percent re-i orcement. Composites are lightweight and can re-p ce metals in missiles, aircraft, and automobiles.

Resin manufacturers may use fillers to improve the c ality of plastics or to extend an expensive resin. Com-m n fillers include powdered wood, talc, and clay.

Vlanufacturers add plasticizers to certain synthetic r ins to make them softer, more flexible, and easier to s ape. Plasticizers overcome the attractive forces be-t een the polymer chains and separate them to prevent i ermeshing.

Pigments change the color of plastics. Resin makers u pigments to produce unlimited varieties of color.

Additives enable resin manufacturers to make plastics e en more useful. For example, vinyl plastics are natural-l clear and rigid. But thanks to additives, vinyl plastics c n be made into products ranging from rigid, gray p e to slightly flexible, black phonograph records to s t, transparent windows for convertible automobile t ps.

Making plastic products. Manufacturers use seven m in processes to shape plastics into products. These processes are (1) molding, (2) casting, (3) extrusion, (4) calendering, (5) laminating, (6) foaming, and (7) thermo-forming.

Molding. There are a variety of molding processes, including compression, injection, blow, and rotational molding. In all these processes, force is applied to the plastic material during and after it enters the mold. Once the product has hardened, it is released from the mold.

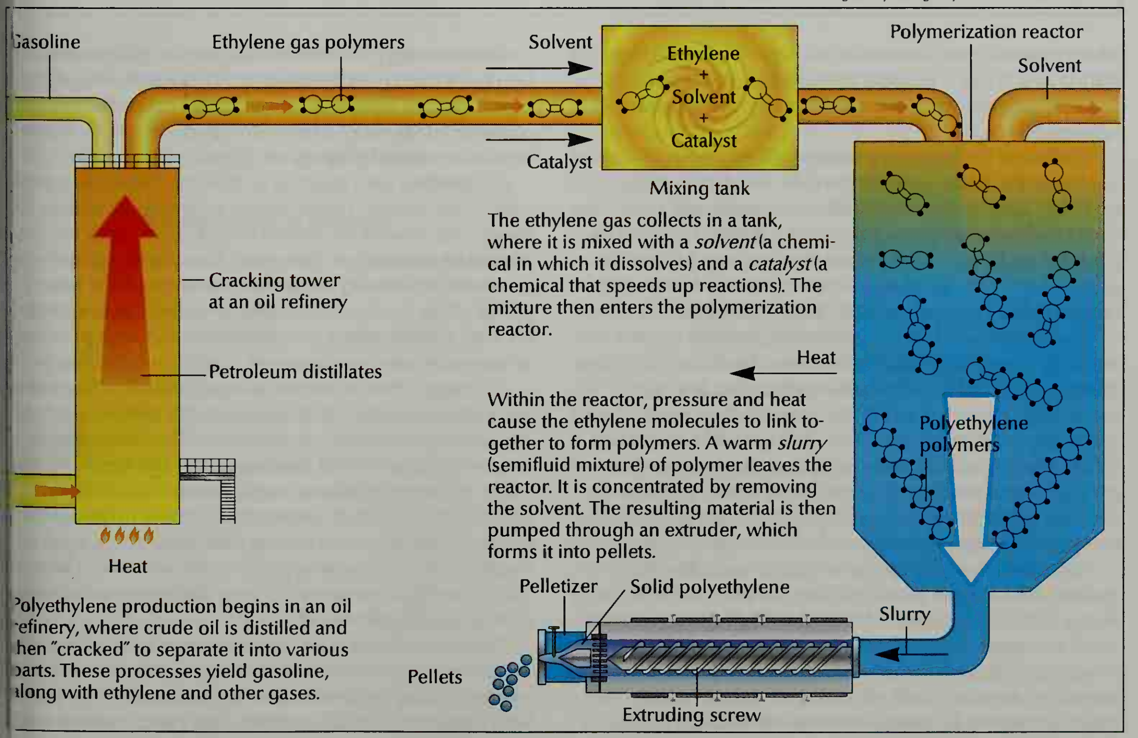
Compression molding is the most common method of molding thermosetting plastics. Compression-molded products include automobile hoods and fenders, electrical switches, and handles for cooking utensils and irons. In compression molding, resin powder is put into a mold. The manufacturer then heats the mold and, at the same time, applies pressure. After the plastics have set, the mold is opened and the product is released. The mold can then be refilled.

Injection molding is the most widely used method of molding thermoplastics. Injection-molded products include telephones, computer housings, automobile steering wheels, and a variety of other items. In injection molding, resin pellets fall from a hopper into a heated, horizontal barrel, where they melt. A plunger or revolving screw inside the barrel pushes the liquid resin under pressure into a mold. Most injection-molded products take only 10 to 30 seconds to harden. The mold is opened, and ejector pins push the formed product out of the mold. The mold is then closed and refilled.

Blow molding is used to make bottles and other hollow objects. In this process, a tube of molten resin, called a *parison,* is inserted into a mold. Compressed

lw plastic resins e made Plastic resins are made primarily from chemicals that come from petroleum. This diagram shows how ethylene, a gas derived from petroleum, is polymerized to form polyethylene plastic resins.

WORLD BOOK diagram by George Fryer, Bernard Thornton Artists



Polyethylene production begins in an oil refinery, where crude oil is distilled and then "cracked" to separate it into various parts. These processes yield gasoline, along with ethylene and other gases.

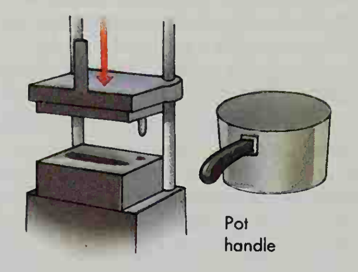
The ethylene gas collects in a tank, where it is mixed with a *solvent* (a chemical in which it dissolves) and a *catalyst* (a chemical that speeds up reactions). The mixture then enters the polymerization reactor.

Within the reactor, pressure and heat cause the ethylene molecules to link together to form polymers. A warm *slurry* (semifluid mixture) of polymer leaves the reactor. It is concentrated by removing the solvent. The resulting material is then pumped through an extruder, which forms it into pellets.

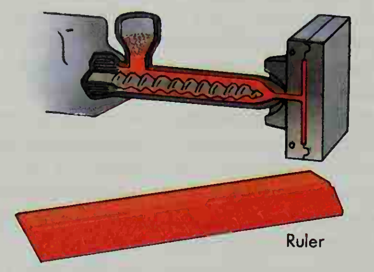
How plastic products are made

Manufacturers make plastic products from plastic resins, which melt into a syrupy liquid when heated. The products are shaped by several methods, as shown in these illustrations.

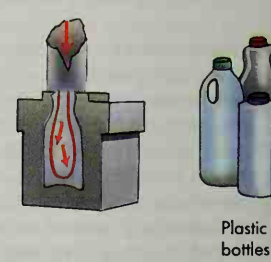
WORLD BOOK illustrations by Paul D. Turnb



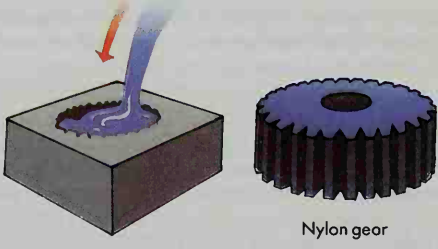
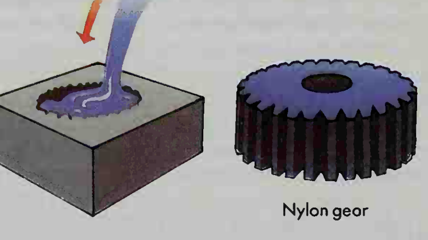
Compression molding uses heat and pressure to shape plastics. The process is commonly used to mold thermosetting plastics.



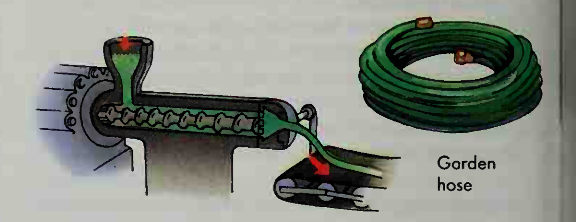
Injection molding shoots molten plastic material under pressure into a mold. It is the most widely used method of molding thermoplastics.



Blow molding produces hollow objects. It uses air or steam to expand a tube of molten resin, forcin the material against a mold's walls.

Casting does not depend on any external pressure to shape the plastics. In the casting process, melted resin is simply poured into a mold. Manufacturers use casting to produce thick, solid objects.



Extrusion is used to produce such continuous forms as pipe, rods, fibers, and wire coatings. Rotating screws force the plastics through a heated barrel, in which they melt, then force them out through a specially shaped die.

air or steam then is forced into the parison, which expands much like a balloon being inflated. This action forces the resin against the walls of the mold, where it is held until it hardens.

Rotational molding also forms hollow objects, such as soccer balls, dolls, and automobile fuel tanks. In this process, a mold is partly filled with powdered resin. The mold is then heated while a motor rotates it slowly. The powder melts as it tumbles inside, coating the mold's inner surface. After all the powder has melted, the still-rotating mold is cooled, and the object solidifies.

Casting, unlike molding, does not depend on any external pressure to shape the plastics. Manufacturers use this method to shape both thermoplastics and thermosetting plastics. To cast thermosets, they pour a liquid resin containing chemicals into a mold and harden it by applying heat. For thermoplastics, the molten resin is poured into a mold and cooled until it sets. Processors employ casting to make thick plastic panels and to produce gears, paperweights, and other solid objects.

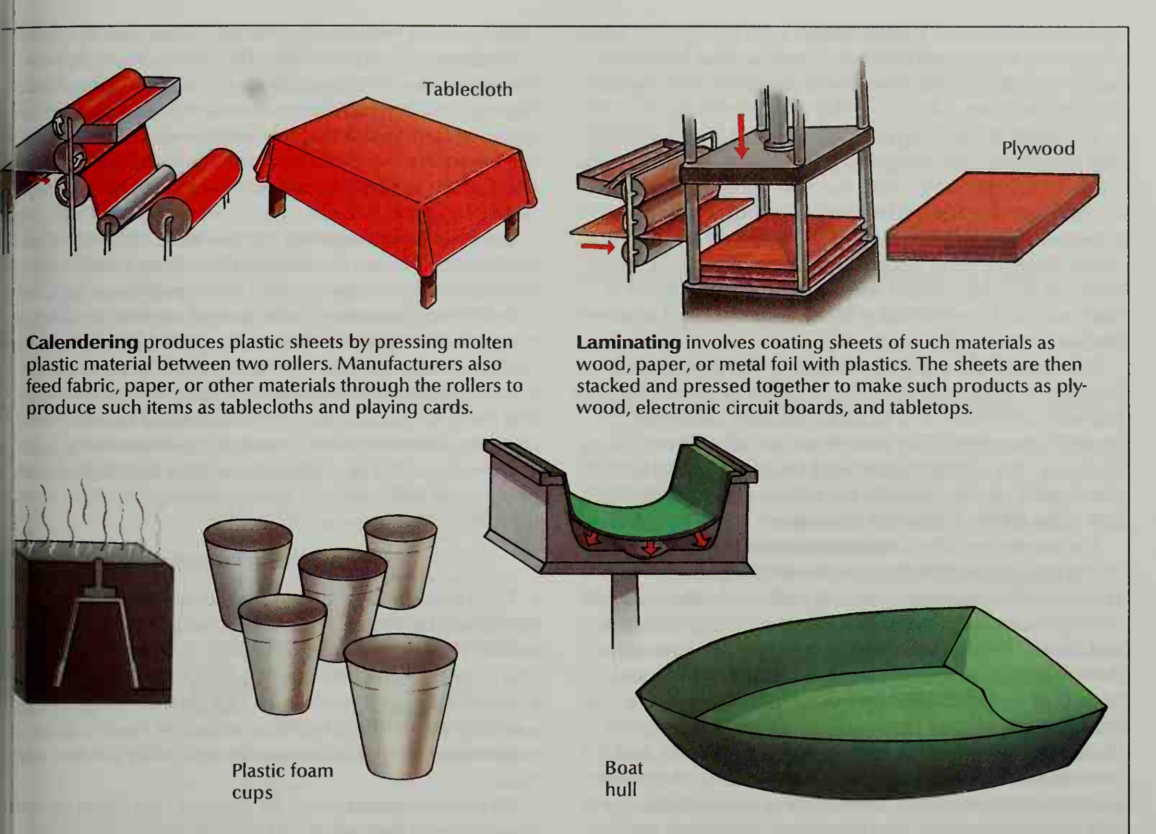
Extrusion is used to produce pipe, rods, fibers, wire coatings, and other products that have the same shape along their entire length. Solid thermoplastics particles from a hopper enter a stationary, heated barrel. One or more rotating screws force the particles through the barrel, where they melt as they are pushed along. The molten material is forced out through a shaping die.

Calendering produces a continuous plastic sheet o film by pressing molten plastics between pairs of polished, heated rollers. Manufacturers feed fabric, pape or metal foil through the rollers to produce such item as plastic-coated playing cards and tablecloths.

Laminating uses plastics to bind together stacks of glass-fiber, wood, paper, cloth, or metal-foil sheets. Th sheets are coated or soaked with a resin. They are the placed one on top of the other. A machine squeezes t sheets together and heats them until the resin has joined them firmly. Laminating produces strong mater als with a wide range of thicknesses for such products as plywood, electronic circuit boards, and tabletops.

Foaming refers to any of several methods that produce plastic foams. All these methods involve introdu ing a gas into heated plastic resins. The gas expands a creates bubbles in the cooling resin. The resulting ma rial is lightweight plastic foam, which is sometimes called *cellular plastic.* Depending on the resins and th method, plastic foams can be stiff and strong, such as those used in packaging and home insulation. Others can be soft and rubbery, such as the foams in furnitur cushions and pillows.

Thermoforming is an inexpensive process used to mold items from sheets of plastics. In this process, workers clamp a plastic sheet over a mold. They then heat the sheet until it becomes soft. Next, a pump suc



Calendering produces plastic sheets by pressing molten plastic material between two rollers. Manufacturers also feed fabric, paper, or other materials through the rollers to produce such items as tablecloths and playing cards.

Laminating involves coating sheets of such materials as wood, paper, or metal foil with plastics. The sheets are then stacked and pressed together to make such products as plywood, electronic circuit boards, and tabletops.

Foaming is any of several methods that produce solid plastics filled with air spaces. To make plastic foam, for example, manufacturers use beads of thermoplastic resin containing a chemical that forms a gas when heated during molding.

Thermoforming is used to mold items from sheets of plastics. A sheet is clamped over a mold and heated until it becomes soft. A vacuum pump sucks air out through tiny holes in the mold, drawing the sheet into the mold.

r out through tiny holes in the mold. This creates a vac-
ım that pulls the soft plastic sheet down until it covers
ıe surface of the mold. There it cools and hardens in
e shape of the mold. Manufacturers use thermoform-
g to produce such objects as bathtubs, shower bases,
ıd yogurt containers.

Development of plastics

For thousands of years, people used natural gums
ıd resins with properties similar to plastics. For exam-
e, the ancient Greeks and Romans created decorative
ɔjects from *amber,* a fossil resin. During the Middle
ges, Europeans used the natural resin *lac,* and its puri-
ed form, *shellac,* to coat objects (see **Lac**).

By the mid-1800's, the commercial molding of plastics-
e natural substances had developed. Manufacturers
olded items from lac, *gutta-percha* (a tree resin), and
her substances obtained from animal, vegetable, and
ineral sources (see **Gutta-percha**). Products made from
ese natural "plastics" included brush handles, knobs,
ectrical insulation, phonograph records, and novelty
ems. Museums and collectors treasure the beautiful
olded objects created during the late 1800's and early
00's.

Despite their beauty, these natural molding materials
ıd several disadvantages. Manufacturers often had dif-
culty obtaining the raw materials. Some materials proved difficult to mold, and many of the finished products turned brittle and broke easily.

The invention of Celluloid. In the late 1860's, John W. Hyatt, a printer from Albany, New York, developed a material to replace the scarce ivory used to make billiard balls. In 1870, he and his brother Isaiah received a patent for the material, which they later named *Celluloid.* Celluloid was the first synthetic plastic material to receive wide commercial use.

Hyatt made Celluloid by first treating *cellulose,* a substance found in cotton, with nitric acid. He then combined the resulting substance, *pyroxylin,* with the solvent *camphor.* The end product, Celluloid, was a hard, stiff material that could be shaped under heat and pressure to form useful items.

Celluloid was used for years to make such products as combs, dentures, and photographic films. However, the material proved to be highly flammable. During the early 1900's, researchers produced a similar, but less flammable, material called *cellulose acetate.* Today, manufacturers use cellulose acetate to make films, fibers, and molded objects. Celluloid itself is still used to make ping-pong balls.

The invention of Bakelite. During the early 1900's, Leo Baekeland, a chemist from New York City, attempted to make a synthetic shellac by combining the chemicals carbolic acid (also known as phenol) and formalde-

hyde. Chemists had experimented with combining these chemicals for several years. But the reaction had been too violent to contain. Baekeland succeeded in controlling the reaction, which created *phenolic resin.*

The resin did not turn out to be the synthetic shellac that Baekeland had sought. But his research was hardly a failure, for he had created the first completely synthetic resin and the first of the thermosetting plastics. He patented it in 1909 and named it *Bakelite,* after his own name. Bakelite soon became widely used to make such items as telephones and handles for pots and irons. It continues to be used today in the electrical and automotive industries.

Growth of the plastics industry. The introduction of Bakelite in 1909 gave scientists a better understanding of polymer chemistry. The plastics industry expanded steadily throughout the next three decades. Scientists in Germany, the United States, and the United Kingdom conducted a great deal of research in plastics, shedding new light on the materials' structures.

The most dramatic developments occurred in the 1920's and 1930's. Four important thermoplastics—acrylics, nylon, polystyrene, and polyvinyl chloride (PVC or vinyl)—came into commercial use. Acrylics are strong and clear. They became widely used for airplane windows. Nylon was used to make women's hosiery and, later, such molded products as bearings and gears. Manufacturers used polystyrene in many products, including clock and radio housings, toys, wall tile, and food containers. PVC, too, had numerous applications, and it found its way into such diverse products as garden hoses, raincoats, wire insulation, and electric plugs. The introduction of specialized machinery to form and mold plastics into useful items also helped the growth of the industry.

Important thermosetting plastics called *unsaturated polyesters* were introduced commercially in the 1940's. Important thermoplastics developed during the 1940's included polyethylene, silicones, and epoxy resins. All of these plastics found new uses during the early 1950's. Polyethylene proved an excellent material for dishes, squeezable bottles, plastic bags, artificial flowers, and other products. Manufacturers used silicones in lubricants and electrical insulation, and physicians used them in body implants. Epoxy resins gained wide use as strong adhesives. Manufacturers used unsaturated polyesters to make boat hulls. In 1953, the General Motors Corporation introduced the Chevrolet Corvette—a sports car with a body made of unsaturated polyester reinforced by glass fibers. The Corvette rolled into history as the first mass-produced automobile with a plastic body.

The uses of plastics continued to grow during the late 1950's and the 1960's. This growth corresponded directly to the growth of the petrochemical industry, which is the major producer of the raw materials for plastics. Engineers found new uses for plastics in medicine, nuclear and space research, industry, and architecture. Polymer chemists developed several new plastics that are especially resistant to chemicals and extreme heat.

Throughout the 1970's and 1980's, plastics continued to find new applications, appearing in such products as microwave cookware, personal computer housings, and compact discs. Aerospace engineers used heat-resistant polyurethane foam to cover the external fuel tanks of t United States space shuttles. This plastic foam acts as heat insulation to prevent loss of fuel by evaporation. During the late 1980's, scientists developed the first practical *conductive plastics,* which—unlike other plas tics—can carry an electric current. Conductive plastics have possible uses in batteries, wiring, and static-resistant fabrics.

Recent developments include the creation of ther moplastics that can be used to make items that must withstand high temperatures. These polymers include polysulfone, polyetherimide, polyphenylene sulfide, a polyetheretherketone. They can be used in medical de vices that must be heat-sterilized, electrical and electronic moldings for high-temperature environments, and parts for automobile engines. *Liquid-crystal polymers* are another type of modern plastics material. Su polymers consist of rodlike molecules that align durin processing and produce items with high strength in th direction of alignment.

The plastics industry

The United States, Japan, and other industrialized na tions lead the world in plastics production. The plastic industry continues to grow rapidly in these countries. The growth of the industry in any country depends on plentiful supply of petroleum.The plastics industry off a variety of job opportunities, including careers in research, design, machine operation, quality control, an sales.

Plastics companies may be divided into three gener groups: *resin manufacturers* (mostly chemical companies) who make and supply resins; *processors* who shape the resins into products; and *finishers and asse blers* who make products by cutting, drilling, decorating, and assembling plastic parts. Most resin manufacturers are in locations that allow easy access to suppli of petroleum. Most processors, finishers, and assemblers operate in areas where they can serve many indu tries.

Plastics and the environment

As more and more plastic packaging materials are used by consumers, more plastic waste is generated. Plastics do not readily break down, and so this waste contributes significantly to environmental pollution by occupying landfill space.

Recycling has emerged as one method of combatin the problem of plastics waste. Industries that produce use large amounts of plastics have recycled their wast for years. Usually they clean and separate the plastics b type. They recycle the thermoplastics by remelting and re-forming them into new products. Thermosets are ei ther ground into fine powders or shredded. The powders are used as fillers. The shreds can be used as insu lation in such products as quilted jackets and sleeping bags.

In the 1980's, many cities and towns turned to recycling to help dispose of consumer plastics waste. Thes communities require citizens to sort certain plastic items—such as polyester soft drink bottles and polyeth ylene milk bottles—from other waste materials. These plastics can be reused in the same manner as industri plastics waste.

Some communities do not separate the plastics but i,tead burn the mixed municipal waste. This process y:lds energy that can be used for electric power or l ating. It requires, however, sophisticated incinerators t it greatly decrease the acid gases produced by the l rning of PVC and other plastics.

Another approach to the disposal problem is to de- s n plastics that can be broken down by nature and t ne. In the 1970's, chemists introduced *biodegradable* p stics. These plastics break down as microorganisms nsume starches or cellulose that are used to separate t e polymer chains. Scientists also created *photode- adable* plastics that break down through long expo- re to sunlight. The polymers in these plastics are de- mposed by a chemical additive that breaks down nen exposed to sunlight.

Joseph A. Biesenberger, Paul G. Kelleher, and Marino Xanthos

Related articles in *World Book* include:

etate	Fiberglass	Phenolic
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llophane	Materials	Polypropylene
mposite materials	Nylon	Polystyrene
e and diemaking	Packaging	Polyvinyl chloride
Pont Company	Petrochemicals	Resin, Synthetic
vironmental pollution		Silicone
rusion		Synthetics
er		Teflon
		Theater (Costumes and makeup)

Outline

I. **How plastics are used**
   A. To replace metals
   B. To replace natural fibers and hides
   C. To replace paper
   D. To replace wood and stone
   E. To replace glass and ceramics
   F. To provide new characteristics
II. **Types of plastics**
III. **How plastics are made**
   A. The chemistry of plastics
   B. Making synthetic resins
   C. Making plastic products
IV. **Development of plastics**
   A. The invention of Celluloid
   B. The invention of Bakelite
   C. Growth of the plastics industry
V. **The plastics industry**
VI. **Plastics and the environment**

Questions

What are the leading plastics-producing countries?
What are some metal products that plastics can replace?
How does casting differ from molding?
What is a *filler?* A *plasticizer?*
How do thermoplastics differ from thermosetting plastics?
What is the chief source of chemicals for the production of synthetic plastics?
What was the first synthetic plastic material to receive wide commercial use?
What is a polymer?
What are some methods for controlling plastic waste?

Additional resources

Cash, Terry. *Plastics.* Garrett Educational, 1990. Younger readers.
Fenichell, Stephen. *Plastic: The Making of a Synthetic Century.* Harper Business, 1996.
Meikle, Jeffery L. *American Plastic: A Cultural History.* Rutgers, 1995.

Plata, Río de la. See Río de la Plata.

Plate tectonics is a theory that explains the origin of most of the major features of the earth's surface. For example, the theory tells us why most volcanoes occur where they do, why there are high ridges and deep trenches in the oceans, and how mountains form.

According to this theory, the earth has an outer shell made up of about 30 rigid pieces called *tectonic plates.* Some of these plates are gigantic. For instance, most of the Pacific Ocean covers a single plate.

The plates move about on a layer of rock that is so hot it flows, even though it remains solid. The plates are moving very slowly relative to one another. They move at speeds up to about 4 inches (10 centimeters) per year.

Plates have been moving about for hundreds of millions of years. So, in spite of their very low speeds, some of them have moved vast distances. In fact, over the past several hundred million years, plate movement has changed the map of the earth drastically. Earth scientists have determined that before about 200 million years ago, all the continents were part of a supercontinent called *Pangaea* (pronounced *pan JEE uh).*

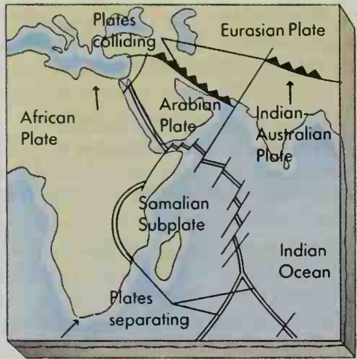
Structure of tectonic plates

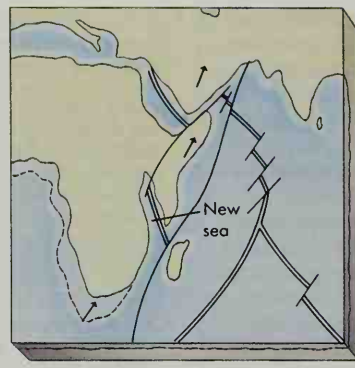
Tectonic plates are made up of the earth's *crust* and the outermost part of its *mantle.* The crust is the outermost layer of the earth. It is thin and rocky. All the dry land, all the ocean floors, and the beds of all the other bodies of water on earth are part of the crust. The man-

EURASIAN PLATE
GORDA PLATE
NORTH AMERICAN PLATE
EURASIAN PLATE
CARIBBEAN PLATE
PHILIPPINE PLATE
PACIFIC PLATE
ARABIAN PLATE
CAROLINE PLATE
COCOS PLATE
INDIAN-AUSTRALIAN PLATE
AFRICAN PLATE
FIJI PLATE
SOUTH AMERICAN PLATE
NAZCA PLATE
INDIAN-AUSTRALIAN PLATE
SCOTIA PLATE
ANTARCTIC PLATE
RLD BOOK map

Earth's tectonic plates

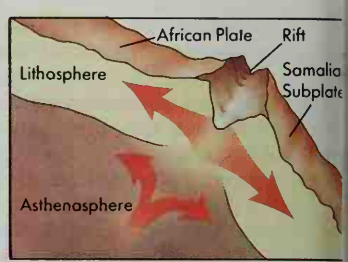
The earth has a rigid outer shell broken up into large slabs of rock called *tectonic plates.* Many of these plates, shown here, include both ocean floor and dry land. Some plates have entire continents embedded in their tops. The plates move slowly about on molten rock underneath the shell. Arrows indicate the directions in which some of the largest plates move.





WORLD BOOK illustration by Charles Wellek

Plate movements are reshaping Africa. The African Plate, in which most of the continent is embedded, is moving north and northeast, *above left,* while the small Somalian Subplate is separating from the African Plate. If these movements continue for 50 million years, *above right,* a new sea will open up along the eastern coast of Africa.



WORLD BOOK illustration by Charles Wel

A rift has already formed in eastern Afr ca, where molten rock of the asthenosphere is rising, pushing apart tectonic plates of the lithosphere. In time, a sea will form along Africa's eastern coast.

tle is a thick layer of hot rock under the crust and above the *core,* a dense sphere at the earth's center. See **Earth** (illustration: Inside Earth).

The continents are embedded in the tops of plates, so as these plates move, they carry the continents along with them. The plates that carry continents do not have the same boundaries as their continents; they include both continents and ocean floor.

Plates are typically about 60 miles (100 kilometers) thick. But they may be less than 5 miles (8 kilometers) thick at certain places in the oceans and as much as 120 miles (200 kilometers) thick under parts of continents.

The plates as a whole make up the earth's *lithosphere.* The layer of mantle rock under the plates is the *asthenosphere* (pronounced *uhs THEEN uh sfihr*). This rock reaches temperatures between about 2400 and 3600 °F (1300 and 2000 °C).

Plate interactions

As the tectonic plates move about on the asthenosphere, they interact with one another at their boundaries. There are three types of boundaries: (1) *divergent,* where plates move apart from each other, (2) *convergent,* where plates move toward each other, and (3) *transform,* where plates slide alongside each other.

Divergent plate boundaries are mostly on ocean floors. There, the separation of plates, or *rifting,* creates lithosphere. Rifting on continents creates gaps into which water flows to form major river systems, lakes, and even oceans.

The rifting of the ocean floor enlarges the floor. *Magma* (liquefied rock) rises from the asthenosphere, filling the gap between the separating plates. The magma hardens, creating equal amounts of new crust on the edges of the two plates. The process of separation of plates and formation of new crust is called *sea-floor spreading.* This process creates about 1 square mile (2.4 square kilometers) of ocean crust a year.

The build-up of ocean crust on plate boundaries generates long underwater mountain ranges called *ocean ridges.* Some of these mountain ranges occur along the center of ocean basins and are called *mid-ocean ridges.* One such mid-ocean ridge, called the *Mid-Atlantic Ridge,* extends from waters east of the Canadian island of Newfoundland to an area off the southern tip of South America. See **Ocean** (map: The land beneath the oceans).

Earthquakes occur at ocean ridges when one plate edge drops down and grinds against the edge of a neighboring plate. These earthquakes occur a short dis tance beneath the surface of the plates, indicating that newly formed plate edges are very thin. See **Earthquak** (Mid-ocean spreading ridges).

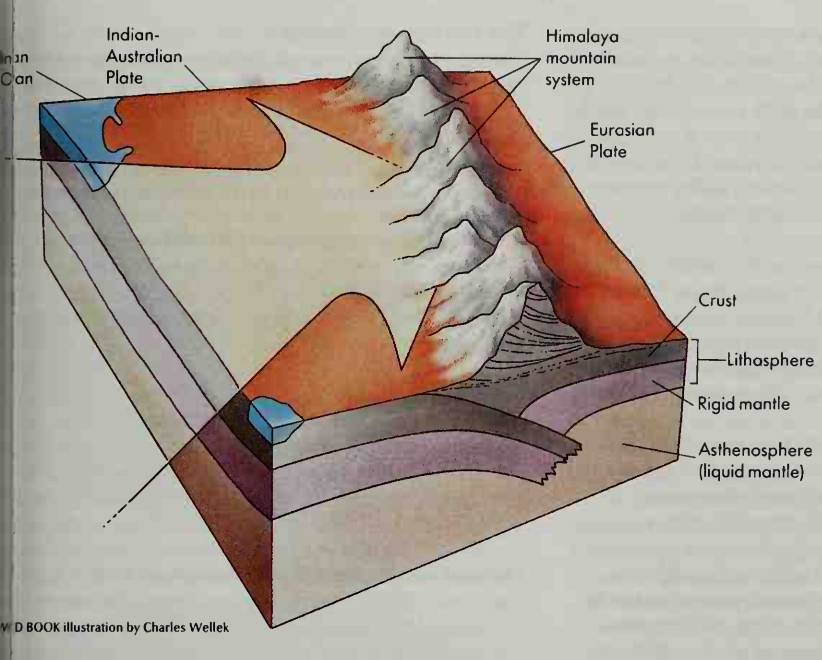
The rifting of continents creates new seas as ocean waters fill a gap in continental crust. The Red Sea region, for example, is in an advanced stage of rifting. Th rift is already flooded by ocean waters—the Red Sea, a extension of the Indian Ocean.

The East African Rift, a unit of the Great Rift Valley th extends from Eritrea to Mozambique and connects to the Red Sea, is in an early stage of rifting. There, the ga is not yet deep enough to become filled with ocean wa ter from the Indian Ocean. However, scientists believe that in 50 million years an extension of that ocean may cut into southeastern Africa.

Convergent plate boundaries are places where lithosphere created at divergent boundaries is destroyed by recycling into the mantle. At a convergent boundary, the edge of a plate sinks, thrusting under th margin of its neighboring plate. This process is called *subduction.* The sinking plate can create deep ocean trenches where it plunges into the asthenosphere. Because the earth is not changing in size, scientists believ that *subduction zones* consume the same amount of ocean crust as ocean ridges create.

The subducting plates generate powerful earthquak and usually create a line of volcanoes along the overric ing plate boundary. A volcano forms when magma, hot gases, and fragments of rock burst through the surface Subduction zones generate magma at a depth of about 75 miles (120 kilometers) by melting three kinds of mate rial: oceanic crust at the top of the descending plate, ocean sediment dragged to great depths, and asthenosphere caught in the corner between the converging plates.

At some convergent plate margins, the overriding plate scrapes a thick mass of sediment off the descend ing plate. This process of *subduction accretion* (pro-



D BOOK illustration by Charles Wellek

The Himalaya, the world's highest mountain system, is a result of the collision of two huge tectonic plates about 40 million years ago. The Indian-Australian Plate struck the Eurasian Plate and began to plunge beneath it. Layers of rock in the Eurasian Plate folded like a tablecloth that is pushed across a table, forming the Himalaya. Today, the Indian-Australian Plate continues to push against the Eurasian Plate.

nced *uh KREE shuhn*), adds material to the edge of overriding plate. In California, for example, subduc- accretion formed a large part of the coastal moun- ranges.

t other convergent plate boundaries, the edge of the cending plate, all its cover of sediment, and even ces from the edge of the overriding plate disappear eath the overriding plate. This process, *subduction sion,* causes continents to shrink. Such erosion is oc- ing in the Pacific Ocean along the coasts of Peru and e and east of the Mariana Islands.

t boundaries where plates carrying continents col-, layers of rock in the overriding plate crumple and like a tablecloth that is pushed across a table. About nillion years ago, a plate that includes what is now country of India collided with the southern edge of Eurasian Plate, which includes Europe and most of . The Indian-Australian Plate began to push beneath Eurasian Plate, causing rock in the Eurasian Plate to mple and fold. Over millions of years, the Himalaya, world's highest mountain system, was formed.

ransform plate boundaries, where plates slide izontally against each other, neither create nor de- y lithosphere. However, at these boundaries, or *sform faults,* powerful earthquakes can occur. For nple, devastating earthquakes have occurred in Cali- ia along parts of a transform plate boundary known ne San Andreas Fault.

he San Andreas Fault forms part of the boundary be- en two large plates—the North American Plate and Pacific Plate. The fault connects a spreading ridge in Gulf of California to a trench off the coast of north- California. The parts west of the fault are attached to Pacific Plate and are moving northwest. See **San An- as Fault.**

Plate movement

ate. Earth scientists measure the speed of plate ement by monitoring how rapidly a plate moves relative to the plate next to it. Today, plates move about 4 inches (10 centimeters) a year—about as rapidly as human hair grows. In the past, plates may have moved as fast as $6\frac{1}{4}$ inches (16 centimeters) per year.

The overall pattern of movement of the tectonic plates is a widening of the Atlantic Ocean and a shrinkage of the Pacific Ocean. The Atlantic is widening because sea-floor spreading at the Mid-Atlantic Ridge continues to create lithosphere. The Pacific is shrinking because much of it is ringed by convergent plate boundaries that are consuming its lithosphere.

Scientists have traced the movements of tectonic plates millions of years into the past. According to the commonly accepted description of plate movement, all the continents once formed part of an enormous single land mass called Pangaea. This mass was surrounded by a giant ocean known as *Panthalassa.*

About 200 million years ago, Pangaea began to break up into two large masses called *Gondwanaland* and *Laurasia.* These masses, in turn, broke up into the continents, which drifted to their present locations.

Evidence of plate movement. Earth scientists find much evidence of plate movement at the boundaries of plates. They study surface features, such as mountains and ocean trenches, and investigate the frequencies and locations of earthquakes and volcanic eruptions.

Volcanoes that rise within plates are also evidence of plate movement. Scientists believe that these volcanoes are caused by *mantle plumes,* columns of very hot mantle that rise from deep inside the earth to the base of the lithosphere. These plumes generate magma that rises through the lithosphere and erupts in places called *hot spots.*

As a plate moves over a hot spot, the spot can generate a chain of volcanoes. For example, a hot spot under the Pacific Plate generated volcanoes that became the Hawaiian islands.

Paleomagnetism (the study of magnetism in ancient rocks) also provides evidence of plate movement. The

evidence is in rocks that contain magnetic particles.

When such a rock was hot and liquid, the magnetic particles moved too rapidly to be influenced by the earth's magnetic field. But as the rock cooled and solidified, the particles aligned themselves with the earth's magnetic field, like tiny compass needles. Thus, the particles continue to point in the direction of the magnetic field that was present during the time that the rock cooled.

So when the plate containing the rock either drifts to a different latitude or rotates, the particles no longer align with the earth's magnetic field. A comparison of the direction in which the particles now point in the rock with the direction of the earth's present magnetic field provides information about where the plate was when the rock solidified.

Causes of plate movement. Tectonic plates slide mostly because of temperature changes and gravity. As an edge that has formed on the ocean floor cools, it shrinks, becoming denser. After about 25 million years of cooling and shrinking, the edge becomes so dense that gravity can pull it down into the asthenosphere. There, the intense heat and increased pressure due to the great depth change the crust of the sunken plate edge into even denser rock. Because of the additional density, gravity pulls the plate edge into the asthenosphere even more strongly.

This sinking action is known as *slab-pull* because the sinking edge pulls the remainder of the slablike plate behind it. Many scientists believe that slab-pull is the main action driving the motion of plates with sinking edges.

Gravity also causes plates to slide downhill away from ocean ridges. This sliding force is called *ridge-push.*

Another cause of plate movement is the simple pushing of plates against one another. Scientists believe that large plates shove some small plates about.

The rise of mantle plumes and other movements of mantle rock may also affect the motion of tectonic plates slightly. The circulation of mantle rock as it rises to the top of the asthenosphere, cools, and then sinks is known as a *convection current.*

Earth scientists once thought that convection currents caused continental drift. Today, however, most earth scientists believe that such currents are primarily a result of the sinking of plates, rather than the cause of plate motion.

Maintaining tectonic activity. The interior of the earth has generated enough heat energy to keep the planet tectonically active since it formed at least 4.5 billion years ago. This energy has maintained tectonic activity by keeping the asthenosphere so soft that the lithosphere can sink into it.

The interior of the earth generates heat energy mainly through the radioactive decay of atoms in the crust and mantle. In radioactive decay, radioactive atoms release energetic particles and rays. Material near these atoms absorbs energy from the particles and rays, becoming hotter.

The production of heat within the earth is declining, mainly because decay is decreasing the number of radioactive atoms. As the earth's heat production is slowing, its interior is cooling. During perhaps the next 5 billion or 10 billion years, this cooling will harden the

The drifting continents

The maps below illustrate the theory of continental drift. The map shows a single land mass—*Pangaea*—about 200 million years ago. The middle map shows Pangaea broken into the la masses *Laurasia* and *Gondwanaland,* and the present contine forming. The arrows show the direction in which the contine moved. The bottom map shows the continents today and whe they may drift during the next 50 million years, *black outlines.*

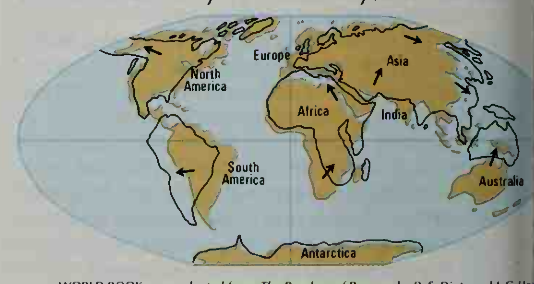
Pangaea: The supercontinent 200 million years ago



The land masses after 65 million years of drift



The continents today and 50 million years from now



WORLD BOOK maps adapted from *The Breakup of Pangaea* by R. S. Dietz and J. C. Ho

asthenosphere so much that plate motion will cease. After that occurs, volcanic eruptions will stop and ear quakes will become infrequent. The earth will be tectonically inactive.

History of tectonic theory

The theory of plate tectonics developed from a the of *continental drift,* presented in 1912 by German met orologist Alfred Wegener. Wegener's theory propose that the continents move about the surface of the eart It explained why the shape of the eastern coast of the Americas and that of the western coast of Africa seem fit together like pieces of a jigsaw puzzle. Evidence fo the drift came from the presence of certain rock depo its that indicate the continents have changed position

r time. For example, rock deposits from glaciers that ted hundreds of millions of years ago are found in ia, Australia, Africa, and South America, indicating these continents were once in a very cold climate, bably near the South Pole. Fossils of tree ferns and er tropical features in North America indicate that it once at the equator.

Vegener was not sure what caused continents to t, however. His theory of continental drift became a ject of much debate among scientists. Then, in the 0's, British physicist Harold Jeffreys proposed that the p interior of the earth was very strong and therefore ld not flow. As a result, most scientists rejected We- er's theory.

lowever, evidence supporting the theory of conti- tal drift gradually accumulated. In the late 1930's, erican geologist David Griggs demonstrated that ap- ently solid rock can flow slowly when subjected to h temperatures and pressures. In the 1940's and 0's, other researchers showed that the ocean floor tains much less sediment than would be expected if floor were a permanent depression. A permanent floor would have accumulated more sediment due the erosion of soil from the continents. The oldest -floor rocks that could be found were less than 150 ion years old.

the 1950's, scientists developed techniques for dying rock magnetism that enabled them to deter- e the positions of the continents millions of years . By the late 1950's, scientists completed mapping a em of ocean ridges extending for about 37,000 miles 000 kilometers) and reaching nearly around the ld.

the late 1950's, scientists discovered that most hquakes occur along lines parallel to ocean ridges trenches. In 1960, Harry H. Hess, an American geolo- , proposed a theory of what came to be called sea- r spreading. In 1967, American geophysicist Jason rgan and British geophysicist D. P. McKenzie inde- dently proposed the idea that the earth's surface sists of a number of movable plates. The following r, American earth scientists Bryan L. Isacks, Jack E. ver, and Lynn R. Sykes combined the idea of sea-floor eading with new results from earthquake detection proposed that rigid plates of lithosphere move ut on a soft, flowing asthenosphere.

1969, the drillship *Glomar Challenger* completed its scientific cruise. Material drilled from various loca- s on both sides of the Mid-Atlantic Ridge indicated the age of the ocean crust was exactly as predicted he analysis of paleomagnetism and sea-floor spread- This discovery and the continuing accumulation of er evidence convinced most earth scientists that the ory of plate tectonics is valid. Mark Cloos

elated articles in *World Book* include:

iate (Continen- l drift)	Hot spot	Ocean
	Island	Ring of Fire
n	Mantle	Seamount
nquake	Mountain	Volcano

Additional resources

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van, Walter. *Continents in Motion.* 2nd ed. Am. Inst. of ysics, 1991.

Plateau is a raised area of relatively flat land. Some plateaus were originally *plains* (low, flat lands) produced by water erosion. Forces within the earth pushed the plains upward, creating the plateaus. Other plateaus lie on rocks that formed in a horizontal arrangement. Many such rocks formed from lava.

Streams often cut deep valleys into plateaus. Valleys with steep sides are known as *canyons.* The awesome Grand Canyon in Arizona, for example, is cut into the Colorado Plateau. Closely spaced rivers may cut a plateau so much that only a small portion of its original surface remains. Such cutting may form peaks known as *erosion mountains.* Rivers formed the Catskill Mountains in New York by cutting into the Appalachian Plateau.

Major plateaus occur at many elevations. The Plateau of Tibet in Asia has an average elevation of about 14,800 feet (4,500 meters). The Altiplano in Bolivia has an aver- age elevation of 13,100 feet (4,000 meters); the Plateau of Mexico, 6,500 feet (2,000 meters). Lower plateaus are in Iran, east and southwest Africa, India, and central Asia. The world's largest plateau, in Antarctica, has an area of about 4,900 square miles (12,700 square kilometers).

Plateaus in many humid regions, such as in Spain and France, provide excellent grazing lands for sheep and cattle. Plateaus of the Appalachian region have valuable deposits of coal. David S. McArthur

See also **Mesa; Plain.**

Platelet. See **Blood** (Platelets; Controlling bleeding).

Plateosaurus, *PLAT ee uh SAWR uhs,* was one of the largest and most widespread early dinosaurs. It lived about 220 million years ago, during the last part of the Triassic Period, in what is now western Europe.

Plateosaurus measured about 26 feet (8 meters) long and weighed up to 4 tons (3.6 metric tons). The dinosaur usually walked on all fours, but it could stand on its powerful hind legs to reach the tree leaves that it ate. *Plateosaurus's* five-fingered hands could grasp food. One finger on each hand had a big curved claw that the animal held above the ground while walking. Scientists think *Plateosaurus* used its claws to dig up vegetation and to defend itself. The dinosaur also had a long, thick tail that it held off the ground.

Plateosaurus's small, narrow head possessed an elon- gated snout and was set at the end of a long, slender neck. The jaw held many leaf-shaped teeth for chopping up plant material. It may also have used *gastroliths,* or stones in its digestive system, to further grind its food.

The German scientist Christian Erich Hermann von Meyer named *Plateosaurus* in 1837. Since then, scien- tists have uncovered large *bone beds* containing the re- mains of many animals. These finds suggest that *Pla- teosaurus* lived or traveled in herds, possibly to avoid seasonal droughts. David B. Weishampel

See also **Dinosaur** (picture: When dinosaurs lived).

Platform tennis is a game in which the players—usually two on each side—use paddles to hit a ball back and forth over a net. The game is played outdoors on a raised court enclosed by a tight wire screen that meas- ures 12 feet (3.7 meters) high. The paddles are larger than those used in table tennis, and they have small round holes in the striking surface. The players use yel- low balls made of sponge rubber.

A platform-tennis court measures 44 feet (13 meters) long and 20 feet (6 meters) wide, and is laid out on a



WORLD BOOK photo by Steinkamp/Ballogg

Platform tennis is played with large paddles and a sponge rubber ball. The raised court is surrounded by a high wire fence.

playing area of 60 feet (18 meters) by 30 feet (9 meters).

The game is played and scored like tennis, with two important differences. A player has only one serve, rather than two as in tennis. Also, a player may return a ball that has landed in the court and bounced against the wire fence. The ball must be returned before it hits the platform a second time. See **Tennis.**

Platform tennis originated in 1928 in Scarsdale, New York. It was played mainly in the northeastern United States until the 1960's, when it began to gain nationwide popularity. The game attracts many players during the winter because it can be played in cold weather and snow can be swept off the platform.

Critically reviewed by the American Platform Tennis Association

Plath, Sylvia (1932-1963), was an American poet and fiction writer. Her works emphasize her sharp insights, ironic wit, and painful feelings. They are especially sympathetic to the plight of women, young people, artists, misfits, and rebels. Plath died young, but she is generally considered one of the most powerful American writers to have emerged since the 1940's.

Plath's poems employ vivid, memorable images to depict a world of anguish. "Daddy" dramatizes the hate and love a young woman feels for her father, who died when she was 10. "Medusa" tells of a daughter's troubled relationship with her mother. In "The Jailer," a wife expresses anger at her brutal, self-centered husband. Poems such as "Ariel" and "Lady Lazarus" explore feelings of despair. "Three Women" presents the thoughts of women as they feel the pain and joy of childbirth.

Plath's fiction, like her verse, frequently explores the dark side of modern life, though usually with humor. In *The Bell Jar* (1963), a college student comes to see her friends as hypocrites and her own values as false. Following a suicide attempt, the student is able to discover new and more satisfying reasons for living. Plath's short stories, collected in *Johnny Panic and the Bible of Dreams* (1977), focus on the central characters' feelings of loneliness and uncertainty.

Plath was born on Oct. 27, 1932, in Boston. Her fathe died when she was a young girl, and her mother worked hard to earn a living. Plath graduated from Smith College in 1955. She married British poet Ted Hughes in 1956. Plath committed suicide at the age of

Though little known at the time of her death, she be came famous with the publication of *Ariel* (1965), a col lection of her poems. *The Collected Poems* (1981) won the Pulitzer Prize for poetry. Plath's writings include a volume of letters to her mother, *Letters Home* (1975); and *The Unabridged Journals of Sylvia Plath:1950-1962* (2000). Steven Gould Axelrod

See also **Hughes, Ted.**

Platinum, *PLAT uh nuhm* (chemical symbol, Pt), is a precious, silver-white metal that is even more valuable than gold. Its atomic number is 78, and its atomic weig is 195.078. Platinum is one of the heaviest substances known. A given quantity of platinum weighs about 21 times as much as an equal quantity of water.

Properties. Platinum has many special characteristi that make it valuable. Only gold and silver are easier to shape than platinum. It can be shaped and worked in a most every possible way. It can be drawn into fine wir or it can be hammered into thin sheets.

Platinum does not corrode or tarnish when exposed to air because it does not combine readily with oxyge or sulfur compounds found in air. Strong acids that dis solve most metals do not attack platinum. Platinum dis solves in a mixture of nitric and hydrochloric acid calle *aqua regia* (see **Aqua regia**).

Platinum has a relatively high melting point of 1772 The metal combines readily with arsenic, phosphorus, and silicon. Platinum also forms alloys with most other metals. The most useful alloys are formed with iridium nickel, osmium, palladium, rhodium, and ruthenium.

Uses. Chemical laboratories often use platinum con tainers because the metal resists heat and chemicals. F the same reason, platinum parts are sometimes used i large-scale production equipment.

Platinum serves as an effective *catalyst,* a substance that speeds up chemical reactions. Automobile manufacturers use platinum in an emission-control device called a *catalytic converter.* The platinum helps to convert certain harmful pollutants into nonpollutants (see **Catalytic converter**). The oil industry also uses platinu to help break down *fractions* (parts) of petroleum to pr duce gasoline of higher octane number (see **Petroleu** [Refining petroleum]). Platinum is also used as a catalys in making various chemicals, such as acetic acid and n tric acid (see **Catalysis**).

The glass industry uses platinum to make dies for fiberglass. Platinum is a favorite material for use in expensive jewelry. Its strength, hardness, color, and freedom from tarnish make it ideal for gem settings. Delicate designs can be made in platinum settings. Platinu is also used on the best surgical instruments.

An alloy of platinum with iridium makes an excellent surface for fine engravings. This same platinum-iridiun alloy is used in making standards of weights and meas ures, contact points for electrical equipment, and the tips of fountain pens. Platinum salts are used in some photographic prints. Certain chemical compounds tha contain platinum are sometimes used to treat cancer.

roduction. The Italian scientist Julius Scaliger dis-
ered platinum in 1557. But fairly large quantities were
discovered until about 1750, when the Spaniards
nd deposits of platinum ore in South America. They
ed the metal *platinum,* from their word *plata,* mean-
silver. The ore, called *native,* or crude, platinum, usu-
occurs in beds of gold-bearing sand. Miners call it
te gold. Native platinum contains from 60 to 85 per-
t pure platinum. Platinum is also obtained from ores
hich it is combined with sulfur or arsenic.

he small, irregular grains that contain the ore also
r other rare metals, such as iridium, osmium, palladi-
rhodium, and ruthenium. These five metals and plat-
n are known as the *platinum-group metals.* Grains
bear platinum-group metals also contain small
unts of iron, copper, chromium, and titanium.
asionally, a large nugget of native platinum will be
nd. In 1843, a lump weighing over 21 pounds (9.5 kilo-
ns) was found in Russia.

outh Africa is the leading platinum-producing coun-
Other producers include Canada, Colombia, Russia,
the United States.

lmost all the platinum produced within the United
es comes from the process of refining copper and
d. Small amounts of platinum occur in copper-bear-
deposits in Arizona and New Mexico.

bert J. Doedens

ee also **Element, Chemical** (table); **Iridium.**

to, *PLAY toh* (427?-347? B.C.), was a philosopher and
cator of ancient Greece. He was one of the most im-
tant thinkers and writers in the history of Western
ure.

Plato's life

ato was born in Athens. His family was one of the
est and most distinguished in the city. His mother,
ctione, was related to the great Athenian lawmaker
on. His father, Ariston, died when Plato was a child.
ctione married her uncle, Pyrilampes, and Plato was
ed in his house. Pyrilampes had been a close friend
supporter of Pericles, the statesman who brilliantly
Athens in the mid-400's B.C.

s a young man, Plato wanted to become a politician.
04 B.C., a group of wealthy men, including two of
's relatives—his cousin Critias and his uncle
rmides—established themselves as dictators in
ens. They invited Plato to join them. However, Plato
sed the offer because he was disgusted by the
up's cruel and unethical practices. In 403 B.C., the
enians deposed the dictators and established a
ocracy. Plato reconsidered entering politics. But he
again repelled when his friend, the philosopher
rates, was brought to trial and sentenced to death in
B.C. Deeply disillusioned, Plato left Athens and trav-
l for a number of years.

387 B.C., Plato returned to Athens and founded a
ool of philosophy and science that became known as
Academy. The school stood in a grove of trees that,
rding to legend, was once owned by a Greek hero
ed Academus. Some scholars consider the
demy to have been the first university. Such subjects
stronomy, biological sciences, mathematics, and po-
al science were investigated there. Except for two
s to the city of Syracuse in Sicily in the 360's B.C.,
Plato lived in Athens and headed the Academy for the
rest of his life. His most distinguished pupil at the
Academy was the Greek philosopher Aristotle (see
Aristotle).

Plato's writings

The dialogues. Plato wrote in a literary form called
the *dialogue.* A dialogue is a conversation between two
or more people. Plato's dialogues are actually dramas
that are primarily concerned with the presentation, criti-
cism, and conflict of philosophical ideas. The characters
in his dialogues discuss philosophical problems and of-
ten argue the opposing sides of an issue. Plato achieved
a dramatic quality through the interaction of the person-
alities and views of his characters. These dramas of ideas
have much literary merit. Many scholars consider Plato
the greatest prose writer in the Greek language—and
one of the greatest in any language.

Plato's better-known dialogues include *The Apology, Cratylus, Crito, Euthyphro, Gorgias, The Laws, Meno, Parmenides, Phaedo, Phaedrus, Protagoras, The Republic, The Sophist, The Symposium, Theaetetus,* and *Timaeus.* A complete edition of Plato's works, collected
in ancient times, consists of 36 works—35 dialogues and
a group of letters. Scholars today generally agree that
about 30 of the dialogues and several of the letters were
actually written by Plato. Scholars have also determined
to a great extent the order in which the dialogues were
written. Thus, Plato's development as a writer and
thinker can be traced.



Detail of *School of Athens* (1510-1511); The Vatican, Rome (SCALA/Art Resource)

The Greek philosopher Plato, *left,* appears with his pupil Aristotle, as pictured by the painter Raphael, in a wall fresco at the Vatican in Rome. Aristotle was greatly influenced by the philosophy of his teacher.

The early dialogues are dominated by Socrates, who appears as a major figure in each. These dialogues include *Charmides, Euthyphro, Ion,* and *Laches.* In these dialogues, Socrates questions people who claim to know or understand something about which Socrates claims to be ignorant. Typically, Socrates shows that the other people do not know what they claim to know. Socrates does not provide answers to the questions. He shows only that the answers proposed by the other characters are inadequate. Most scholars consider these so-called *Socratic dialogues* to be fairly accurate portrayals of the actual philosophic style and views of Socrates. See **Socrates** (The Socratic method).

The later dialogues. In the later dialogues, Plato uses the character of Socrates merely as his spokesman. These dialogues include *The Republic, The Sophist,* and *Theaetetus.* In these works, Socrates criticizes the views of others and presents complex philosophical theories. Thus, the later dialogues offer more complete and positive answers to questions being considered than do the early dialogues. But they lack much of the dramatic and literary quality of the earlier writings.

Plato's philosophy

The theory of forms. Many of Plato's dialogues try to identify the nature or essence of some philosophically important notion by defining it. The *Euthyphro* revolves around a discussion and debate of the question, "What is piety?" The central question of *The Republic* is, "What is justice?" The *Theaetetus* tries to define knowledge. The *Charmides* is concerned with moderation, and the *Laches* discusses valor. Plato denied that a notion, such as *piety* (reverence), could be defined simply by offering examples of it. Plato required a definition of a notion to express what is true of, and common to, all instances of that notion.

Plato was interested in how we can apply a single word or concept to many different things. For example, how can the word *table* be used for all the individual objects that are tables? Plato answered that various things can be called by the same name because they have something in common. He called this common factor the thing's *form* or *idea.*

According to Plato, the real nature of any individual thing depends on the form in which it "participates." For example, a certain object is a triangle because it participates in the form of triangularity. A particular table is what it is because it participates in the form of the table.

Plato insisted that the forms differ greatly from the ordinary things that we see around us. Ordinary things change, but their forms do not. A particular triangle may be altered in size or shape, but the form of triangularity can never change. In addition, individual things only imperfectly approximate their forms, which remain unattainable models of perfection. Circular objects or beautiful objects are never perfectly circular or perfectly beautiful. The only perfectly circular thing is the form of circularity itself, and the only perfectly beautiful thing is the form of beauty.

Plato concluded that these unchanging and perfect forms cannot be part of the everyday world, which is changing and imperfect. Forms exist neither in space nor time. They can be known only by the intellect, not by the senses. Because of their stability and perfection, the forms have greater reality than ordinary objects observed by the senses. Thus, true knowledge is the knowledge of forms. These central doctrines of Plato's philosophy are called his *theory of forms* or *theory of ideas.*

Ethics. Plato based his ethical theory on the propos tion that all people desire happiness. Of course, peop sometimes act in ways that do not produce happiness But they do this only because they do not know what tions will produce happiness. Plato further claimed th happiness is the natural consequence of a healthy stat of the soul. Because moral virtue makes up the health the soul, all people should desire to be virtuous. Plato said that people sometimes do not seek to be virtuou but only because they do not realize that virtue produces happiness.

Thus, for Plato, the basic problem of ethics is a prol lem of knowledge. If a person knows that moral virtue leads to happiness, he or she naturally acts virtuously. Plato differed from many Christian philosophers who have tended to view the basic problem of ethics as a problem of the will. These philosophers argue that oft people know what is morally right, but face their grea est problem in *willing* to do it.

Plato argued that it is worse to commit an injustice than to suffer one, because immoral behavior is the symptom of a diseased soul. It is also worse for a pers who commits an injustice to go unpunished than to b punished, because punishment helps cure this most s rious of all diseases.

Psychology and politics. Plato's political philosop like his ethics, was based on his theory of the human soul. He argued that the soul is divided into three part (1) the rational part, or intellect; (2) the spirited part, or will; and (3) appetite or desire. Plato argued that we know the soul has these parts because they occasiona conflict with each other. For example, a person may d sire something but fight this desire with the power of the will. In a properly functioning soul, the intellect—t highest part—should control the appetite—the lowest part—with the aid of the will.

Plato described the ideal state or society in *The Republic.* Plato wrote that, like the soul, this state or society has three parts or classes: (1) the philosopher king who govern the society; (2) the guardians, who keep order and defend the society; and (3) the ordinary citizens, farmers, merchants, and craftworkers who provi the society's material needs. The philosopher kings re resent the intellect, the guardians represent the will, a the ordinary citizens represent the appetites. Plato's ideal society resembles a well-functioning soul becau the philosopher kings control the citizens with the aid the guardians.

Immortality of the soul. Plato believed that thoug the body dies and disintegrates, the soul continues to live forever. After the death of the body, the soul migrates to what Plato called the *realm of the pure form* There, it exists without a body, contemplating the form After a time, the soul is reincarnated in another body and returns to the world. But the reincarnated soul retains a dim recollection of the realm of forms and year for it. Plato argued that people fall in love because the recognize in the beauty of their beloved the ideal form of beauty that they dimly remember and seek.

n the *Meno,* Plato has Socrates teach an ignorant sl e boy a truth of geometry by simply asking a series o questions. Because the boy learns this truth without b ng given any information, Plato concluded that learn- ir consists of recalling what the soul experienced in th realm of the forms.

rt. Plato was critical of art and artists. He urged strict c sorship of the arts because of their influence on m lding people's characters. Using his theory of forms, Pl o compared artists unfavorably with craftworkers. He d lared that a table made by a carpenter is an imper- fe copy of the ideal form of a table. A painting of a ta e is thus a copy of a copy—and twice removed from th reality of the ideal form.

lato claimed that artists and poets cannot usually ex- p n their works. Since artists do not even seem to k w what their own works mean, Plato concluded that th y do not create because they possess some special k wledge. Rather, he believed that artists create be- c se they are seized by irrational inspiration, a sort of "c ine madness."

Plato's place in Western thought

fter Plato died, his nephew Speusippus took over th leadership of the Academy. The school operated un- ti .D. 529. That year, the Byzantine Emperor Justinian I c sed all the schools of philosophy in Athens because h felt they taught paganism. However, Plato's influence w s not confined to the Academy. Plato's philosophy d eply influenced Philo, an important Jewish philoso- p er who lived in Alexandria shortly after the birth of C ist. During the A.D. 200's in Rome, Plotinus devel- o ed a philosophy based on Plato's thought. This new v sion of Plato's philosophy, known as *Neoplatonism,* h great influence on Christianity during the Middle A es. See **Plotinus; Neoplatonism.**

lato dominated Christian philosophy during the early M ddle Ages through the writings of such philosophers a Boethius and Saint Augustine. During the 1200's, Aris- t e replaced Plato as the greatest philosophical influ- e e on the Christian world. A revival of interest in Plato d veloped during the Renaissance. During the 1400's, th Medici family, famous patrons of the arts, estab- li ed a Platonic Academy in Florence as a center for the s dy of Plato's philosophy.

n the mid-1600's, an important group of English philosophers at Cambridge University became known as the Cambridge Platonists. They used the teachings of Plato and the Neoplatonists to try to harmonize reason with religion. Ivan Soll

Related articles in *World Book* include:

Aristotle
Atlantis
Neoplatonism
Peripatetic philosophy
Philosophy (Ancient philosophy)
Political science (The development of political science)
Socrates

Additional resources

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Platte River, *plat,* is the most important river in Nebraska and one of the largest branches of the Missouri River. The Platte River is formed by the union of the North Platte and South Platte rivers, both of which begin in the mountains of Colorado. The two rivers join near the city of North Platte, in western Nebraska (see **Nebraska** [physical map]). From this junction, the Platte River flows east and empties into the Missouri at Plattsmouth.

The North Platte flows 618 miles (995 kilometers), and the South Platte is 424 miles (682 kilometers) long. The main stream is about 310 miles (499 kilometers) long. The Platte and its branches drain a region of about 90,200 square miles (233,600 square kilometers). The Platte is too shallow for navigation. However, its valley provides a flat pathway, which has been followed by pioneers, the Union Pacific Railroad, and the Interstate 80 highway. David Wishart

Platypus, *PLAT uh puhs,* is one of only two mammals that reproduce by laying eggs. The echidna is the other. Platypuses are often called *duckbills* because they have a broad, flat, hairless snout similar to a duck's bill.

Platypuses live along streams in Australia. They have webbed feet and a broad, flat tail that aid in swimming. The platypus uses its bill to scoop up worms, small shellfish, and other animals from the bottom of streams. Adult platypuses lack teeth. They crush their food with horny pads at the back of the jaws. Platypuses grow from 16 to 22 inches (41 to 56 centimeters) long, includ-

Robin Smith, Photographic Library of Australia



The platypus has a broad, flat tail and webbed feet that aid in swimming. It lives along streams in Australia and is often called the *duckbill* because its snout resembles the bill of a duck. The platypus and the echidna are the only mammals that lay eggs.

ing a tail of 4 or 5 inches (10 to 13 centimeters). They weigh about 5 pounds (2.3 kilograms) but appear heavier because of their thick coat of brown fur.

The platypus has claws on its front and hind feet, but the webs of the front feet can be extended beyond the claws. The platypus folds these webs against the palms when walking on land or digging in the ground. Male platypuses also have a hollow clawlike *spur* behind each ankle. The spurs are connected to poison glands, which enlarge during the mating season. Scientists believe the male platypuses might use the spurs for defense.

Platypuses live in burrows that they dig in the banks of streams. The burrows may be as long as 85 feet (26 meters). Except for female platypuses with their young, each animal lives in its own burrow. During the mating season, the female platypus builds a nest of leaves and grass at the end of her burrow. Before laying her eggs, she blocks the entrances to the burrow with dirt. Female platypuses lay from one to three eggs at a time. The eggs measure about $\frac{1}{2}$ inch (1.3 centimeters) in diameter and have a leathery shell. Platypus eggs hatch after about 10 days. Young platypuses remain in their mother's burrow for about four months and feed on their mother's milk.

At one time, platypuses were hunted for their fur. Since the 1920's, however, the killing of platypuses has been prohibited by law.

Scientific classification. The platypus makes up the family Ornithorhynchidae in the mammalian order Monotremata. Its scientific name is *Ornithorhynchus anatinus.* Michael L. Augee

See also **Mammal** (picture: Monotremes).

Plautus, *PLAW tuhs* (254?-184 B.C.), was an important Roman writer of comedy. His plays are versions of Greek New Comedy, which emphasized young men in love with slave girls, mistaken identities, cunning servants, and deceived masters. Plautus added earthy Italian comic elements and his own boisterous wit. Subtle techniques of plot construction and characterization did not concern him as much as producing laughter. He was a master of dialogue, writing a lively stream of puns, love talk, and abuse.

Plautus wrote many plays, of which 21 have survived. *Amphitruo* is a mythological story about the god Jupiter fathering Hercules with a human man's wife. In *Menaechmi,* two long-separated brothers find each other after great confusion. In *Casina,* father and son are rivals for the same girl.

Titus Maccius Plautus was born in Sarsina, Italy. He apparently worked as a stagehand before turning to playwriting. Anthony A. Barrett

Play. See **Drama; Theater.**

Play, in recreation, is any activity performed for amusement. Although people engage in play mainly to enjoy themselves, play also contributes to the physical and mental health of individuals. For example, many people increase their physical fitness by swimming or hiking. Many people also improve their intellectual skill by playing word games or solving puzzles.

Play activities fall into one of three general groups—(1) motor play, (2) intellectual play, or (3) sensory play. Motor play is physical exercise, such as skating or playing volleyball. Intellectual play primarily involves mental activity, as in playing chess. Sensory play includes spectator activities, such as attending sports events.



L. L. T. Rhodes, Click/Chi

Intellectual play involves mental activity. Chess players, *abo*[ve,] must use their powers of concentration in order to evaluate a large number of possible moves and strategies.

Play takes countless forms. A person may bounce a ball alone or join in a game of basketball with several other people. Play activity may or may not be planned ahead of time. It can take place anywhere, from in an individual's mind to areas designed specifically for play, such as sandboxes, playgrounds, recreation rooms, ar[nd] athletic fields.

Some play activities are popular with both children and adults. Other activities appeal primarily to people [of] certain age groups. Children often take part in play tha[t] requires a great deal of imagination, such as playing with dolls or dressing up and pretending to be adults. Adult play activities generally involve more structured types of recreation, such as hobbies, sports, and game[s.]

For a child, playing is a form of self-expression and [a] significant part of social development. Children begin [to] play long before they can communicate effectively wit[h] words. Through playing, they express their ideas, moods, problems, and personalities to other people. Children learn to interact with one another by sharing toys or playing games that stress personal cooperatio[n,] such as tag or hide-and-seek. When they are older, the[y] develop teamwork skills by playing competitive sports like volleyball.

For an adult, playing is a way of relaxing during leisure time. Play activities help relieve pressures caused by the tensions of daily life. Roger A. Lancaster

Related articles in *World Book* include:

Animal (Learning and play)	Playground
Child (pictures)	Recreation
Doll	Safety (Safety in recreation)
Game	Sports
Hobby	Storytelling
Kindergarten	Toy
Occupational therapy	Video game
Physical education	



Glennon P. Donahue, Click/Chicago

Children at a playground climb and slide on the equipment. The grass field behind the equipment is used for games and sports for older children and adults. City planners usually provide for playgrounds in communities, and most schools have them.

Pıyground is an outdoor area set aside for play. Playg unds were first started for children. But people of all a s enjoy the many different playground activities offed today.

 mall children can play informally in sand piles, and o seesaws and swings. Older boys and girls may play o practice a variety of games and sports on the playg und. Adults may participate in such games as tennis, b minton, and horseshoes. Many playgrounds have s ficient space for basketball, baseball, and even footb l and soccer. Some playgrounds have outdoor swimm g pools.

 laygrounds often become a center of community acti ty. Parents come to watch competitive contests and c er special events. Holiday celebrations, such as those c the Fourth of July and Labor Day, are often held in p ygrounds. Many schools hold yearly play days on p ygrounds.

 efore 1900, children played on the lawns of their h mes, in vacant lots, and in the streets. The movement f public playgrounds was started shortly before 1900 b Jacob Riis, a New York City newspaperman. Riis and c ers recognized the great need for play space and r reation activities in the growing cities. The slum a as had no lawns or vacant lots for play. Most of the e ly schools did not have land around them that could b used for play. By 1899, Boston had 21 sand lots for s all children.

 Other Eastern cities followed Boston's example, and s n sand gardens and playgrounds were being organi d in several cities. In 1889, the Charlesbank Outdoor (mnasium opened in Boston. This recreation area pro ed apparatus for gymnastics, a running track, and s ice for games for older boys and men. A section was a led two years later for women and girls.

 Today, practically all schools have playgrounds. Cities h e several playgrounds located in various community tricts. City playgrounds are usually under the direct n of park and recreation boards. Sometimes they are developed and controlled jointly by park districts, school boards, and recreation commissions. Playgrounds are usually provided for in modern city planning. Building ordinances often require that new communities include space for parks and playgrounds.

Playground programs are planned and conducted by trained playground leaders who usually have majored in physical education and recreation in college. They learn how to plan and conduct playground activities according to the educational, growth, and developmental needs of boys and girls. Walter Harold Gregg

See also **Game** (Recreation); **Gymnasium**; **Park** (Kinds of parks); **Play**; **Recreation**.

Playing cards. See **Card game**.

Plea bargaining is a practice in which the defendant in a criminal case agrees to plead guilty instead of going to trial. In some cases, the prosecuting attorney promises to drop one or more charges or to substitute a less serious charge in exchange for a guilty plea. Such a procedure is called *charge bargaining.* In a process called *sentence bargaining,* the prosecutor promises to recommend that the accused receive a lighter sentence than ordinarily would be given. In the United States, about 90 per cent of all defendants plead guilty, most as a result of plea bargaining. A defendant who engages in bargaining is sometimes said to be "copping a plea."

The government saves time and money by plea bargaining rather than deciding each case by trial. Many lawyers and other experts on criminal justice favor plea bargaining because it allows district attorneys to vary punishment, depending on the individual circumstances of the crime. Other supporters believe that a lawbreaker who openly acknowledges guilt has shown regret and deserves a lighter sentence.

Many critics of plea bargaining believe it allows large numbers of criminals to be punished less severely than they deserve. Other opponents fear that the procedure jeopardizes a defendant's right to be considered innocent until proved guilty. They argue that plea bargaining

may force even innocent persons to agree to a criminal charge because of a fear of going to trial. As a result of such criticisms, many states have established rules to prevent abuse of the system. In some states, lawyers must report in open court the promises made during plea-bargaining sessions. Jack M. Kress

Plebeians, *plih BEE uhnz,* were commoners in the early Roman Republic. The plebeians included freed slaves, peasant farmers, and dependents of *patricians* (aristocrats). It is not known how the difference between plebeians and patricians first arose, but it existed by the early 500's B.C. Plebeians who owned property served in the army and, like the rest of their class, were denied many rights. For many years, they could not hold public office, vote on laws, or become priests. They were forbidden to marry persons not of their class. Judges often treated the plebeians unfairly.

Early in the 400's B.C., the plebeians threatened to refuse to fight unless they were allowed to choose their own *tribunes* (officials). The plebeians were given the right to elect tribunes who could *veto* (reject) unfair acts of judges and lawmakers. Later, in 445 B.C., the plebeians received the right to marry patricians. In 367 B.C., they were allowed to run for the office of *consul* (chief government official). By 300 B.C., they had been declared eligible for the priesthoods and other offices. In 287 B.C., the *comitia tributa* (assembly of all the people—plebeians and patricians alike) was given the power to make laws that bound everyone.

Wealthy plebeians then began joining the patricians to form a new upper class. But tribunes and the *comitia* remained to protect the poor classes of Rome until the end of the republic, in 27 B.C. D. Brendan Nagle

See also **Patricians; Praetor; Tribune.**

Plebiscite, *PLEHB uh syt,* is a vote of the people on any question. But the term has come to mean the vote of inhabitants in a territory to choose the nation that will govern them. The plebiscite was first used during the 1790's when the citizens of Nice and Savoy voted for or against union with France.

Modern plebiscites are almost always under international supervision. In 1975, for example, the United Nations (UN) sent observers to witness a plebiscite in the Northern Mariana Islands in the Pacific Ocean. The islands were governed by the United States as part of a UN trust territory. In the plebiscite, the people voted to become a commonwealth of the United States. Plebiscites also decided the status of the Saar in Europe and British Togoland in Africa.

Plebiscites are intended to give territories freedom of choice, but interested nations sometimes try to influence the vote by military pressure. In any case, plebiscites have marked a long step forward in permitting people of certain territories some freedom in choosing their form of government. Robert Agranoff

Plecoptera, *pluh KAHP tuh ruh,* is an order of insects that lay their eggs in water. The young live in streams or along the rocky shallows of ponds and lakes. They form a large part of the diet of trout and other fish. The adults have wings but do not fly well and seldom wander far from their breeding place. The insects are known as *stoneflies* because the young find shelter under stones. See also **Stonefly.**

Pledge. See **Oath.**

Pledge of Allegiance is a solemn promise of loyalt to the United States. It reads:

> I pledge allegiance to the flag of the United States of America and to the Republic for which it stands, one Nation under God, indivisible, with liberty and justice for all.

Public-school children first recited the pledge as the saluted the flag during the National Public Schools Cel bration held in 1892 to mark the 400th anniversary of th discovery of America. The original pledge was most likely written by Francis Bellamy (1855-1931), though some people later claimed that James B. Upham (1845-1905) wrote the pledge. Both men were from Boston a worked for *The Youth's Companion.* A panel of schola gave the credit to Bellamy in 1939. The National Flag Conferences of the American Legion expanded the ori inal wording in 1923 and 1924. In 1942, Congress made the pledge part of its code for the use of the flag. In 1954, it added the words "under God." Whitney Smith

Pleistocene Epoch, *PLYS tuh seen,* was a geologic time period in the earth's history. Many earth scientists believe this epoch began about 2 million years ago an ended about 11,500 years ago. The Pleistocene Epoch i cluded numerous periods called *ice ages,* when ice sheets covered large regions of land. Anthropologists believe an early form of human being gradually developed into the modern form during the Pleistocene Epoch. See also **Ice age; Earth** (table: Outline of Earth's history); **Prehistoric people.**

Plekhanov, *plih KHAH nahf,* **Georgi Valentinovich,** *geh AWR gih VAH lehn TEE nah vihch* (1856-1918), was a leading advocate and interpreter of Marxi ideas in Russia during the late 1800's and early 1900's. Plekhanov, the youngest son of a minor noble, was bo on Dec. 11, 1856, in Gudalovka, near Tambov, Russia. A a young man, he joined a revolutionary movement that wanted to establish socialism in Russia. In 1880, he fled to Switzerland to escape arrest for his political activitie There, he became a follower of Karl Marx, the German founder of Communism.

Plekhanov adapted Marx's ideas to Russian conditio and projected a two-stage revolution to achieve a soci ist state. In the first stage, the working and middle clas es would defeat the Russian monarchy. In the second stage, the workers would overthrow the middle class and come to power.

In 1883, Plekhanov helped found the first Russian Marxist organization, the Emancipation of Labor group This group led to the formation of the Russian Social Democratic Labor Party in 1898. At its second convention in 1903, the party adopted a platform based on Plekhanov's theory of a two-stage revolution.

Plekhanov disagreed with V. I. Lenin, another Russia socialist, on many political questions. Their differences came to a head during World War I (1914-1918). Plekhanov wanted Russia to remain in the war and hel France and Britain to win. Lenin proposed to turn the war into a worldwide revolution. In 1917, Lenin and his followers seized power and established a Communist government in Russia. Helmut Gruber

Plessy v. Ferguson was a landmark decision of the Supreme Court of the United States concerning racial segregation. In this 1896 ruling, the court established the policy of "separate but equal" public facilities for

blacks and whites. The decision formed the basis of widespread segregation in the South for over 50 years.

The case began in 1892, when Homer A. Plessy challenged a Louisiana law that required separate but equal facilities for blacks and whites in railroad cars. John H. Ferguson, a criminal district court judge, overruled Plessy's plea that the law was unconstitutional. Plessy then brought action against Ferguson. Plessy argued that the law violated a clause of the 14th Amendment to the U.S. Constitution that guaranteed citizens equal protection of the laws. The Supreme Court ruled that the amendment did not seek to guarantee the social equality of all races. The court upheld the Louisiana law. Segregation of the races in the South continued, though facilities for blacks were nearly always inferior to those for whites. Stanley I. Kutler

See also **Brown v. Board of Education of Topeka.**

Pleura, *PLUR uh,* is a thin membrane that lines the *thoracic cavity* (chest cavity) and covers the lungs. The part covering the lungs is called the *visceral pleura,* or *pulmonary pleura.* The remaining part, called the *parietal pleura,* lines the chest wall and covers the diaphragm. The two parts of the pleura unite at the root of the lung, where the *bronchus* (branch of the windpipe) and blood vessels enter the lung.

In a healthy person, the two parts of the pleura touch. They secrete a trace of watery fluid that lubricates their surfaces. Inflammation of the pleura, a condition called *pleurisy,* can cause fluid to accumulate between the two pleural surfaces, possibly compressing the lung underneath. If a hole develops in the surface of the lung, air enters the space between the pleural surfaces. This condition, called *pneumothorax,* may cause the lung to collapse. Robert A. Klocke

See also **Lung; Membrane; Pleurisy; Pneumothorax.**

Pleurisy, *PLUR uh see,* is a general term for inflammation of the *pleura,* a membrane that lines the inside of the chest and covers the lungs (see **Pleura**). The two surfaces of the pleura are normally moist and allow the lungs to move smoothly over the chest wall when a person breathes. When the pleura is inflamed, its surfaces become dry and rough and rub together. The inflammation stimulates pain receptors in the pleural lining of the inside of the chest and causes intense pain, made worse by coughing and deep breathing.

Pleuritic pain is often accompanied by *pleural effusion,* an accumulation of excessive amounts of liquid in the space between the two parts of the pleural membrane. In some cases, so much fluid collects in this cavity that the lungs become compressed and cannot inflate normally. Chills and fever, coughing, and difficulty in breathing may also accompany pleurisy.

Most cases of pleurisy occur as complications of pneumonia, tuberculosis, or other infectious diseases. Physicians must therefore treat the underlying disease in order to cure pleurisy. A doctor may prescribe drugs to relieve the pain of a person with pleurisy. In cases of pleural effusion, a physician may drain fluid from the patient's chest. Michael G. Levitzky

Plexus, *PLEHK suhs,* in anatomy, is a network of interwoven parts. In a nerve plexus, such as the *brachial plexus* that supplies the arm, there is a complex interweaving of nerve fibers. In a vascular plexus, made up of arteries, veins, or lymphatic vessels, the vessels are connected with each other. See also **Solar plexus.**

Delmas J. Allen

Plimsoll mark, *PLIHM suhl,* is a load-line marking on the side of a ship's hull. It shows the *draft* a ship can be safely loaded to under certain conditions. The draft is the depth to which a ship sinks in the water. The position of the marking depends on the type and size of the vessel. A ship loaded "down to the Plimsoll mark" carries the maximum weight of cargo. Any more cargo would lessen the ship's chances of a safe voyage.

The name comes from Samuel Plimsoll, a member of the British Parliament who was active in promoting the Merchant Shipping Act of 1876. This act was the first legislation to require a draft mark on the side of a vessel beyond which it could not be loaded.



South Street Seaport Museum

A Plimsoll mark, like the one being measured above, indicates how much cargo a ship can carry safely. A ship has the maximum cargo when the water level reaches the horizontal line.

Load-line regulations for American ships have been established by the United States Coast Guard as provided under the Load Line Act of 1929 and the Load Line Convention of 1966, an international treaty signed by the world's seagoing nations. These rules apply to deep-sea vessels of 150 gross tons or more.

The distance between the Plimsoll mark and the deck is the ship's "freeboard." Special markings were established in 1935 for Great Lakes and Atlantic and Pacific coast voyages. In 1973, Canada and the United States agreed on revised load-line regulations for ships traveling on the Great Lakes. Robert F. Beck

Pliny the Elder, *PLIHN ee* (A.D. 23 or 24-79), was a Roman writer. Pliny wrote many historical and technical works, but only his 37-volume *Natural History* has survived. Although this work was much used during the Middle Ages, its main value now is to show the state of scientific knowledge during Pliny's time. See **Geology** (The Romans).

Pliny was born in Novum Comum (now Como) in northern Italy. His given and family name was Gaius Plinius Secondus. As a lawyer, he held important public offices. He was commander of the fleet near Pompeii

when Mount Vesuvius erupted in A.D. 79, and he died there trying to help the refugees. His nephew, Pliny the Younger, was also a famous writer. Anthony A. Barrett

Pliny the Younger, *PLIHN ee* (A.D. 61 or 62-113?), was a Roman writer. He was the nephew of another Roman writer, Pliny the Elder. His most important works are his *Letters,* collected in 10 books. They show the life and interests of a Roman gentleman, scholar, and philanthropist. The letter addressed to the historian Tacitus gives a detailed account of the eruption of Vesuvius, and describes the death of his uncle. Pliny the Younger served as governor of Bithynia and Pontus, and wrote letters to the Emperor Trajan describing the Christians and asking what to do about them. These letters are the earliest accounts of Christians written by a pagan.

Pliny the Younger was born in Novum Comum. His given and family name was Gaius Plinius Caecilius Secundus. By the age of 20, he was considered one of the most learned people of his time. He studied under Quintilian and was a good orator. Anthony A. Barrett

Pliocene Epoch. See **Earth** (table: Outline of the earth's history).

PLO. See **Palestine Liberation Organization.**

Plot. See **Drama** (The structure of drama); **Literature** (Plot).

Plotinus, *ploh TY nuhs* (205?-270?), was the founder of a school of Greek philosophy known as *Neoplatonism.* He developed Neoplatonism from the philosophy of Plato (see **Neoplatonism**). Plotinus said that the material world is unreal, politics trivial, the body a temporary prison for the soul, and life a journey through a landscape of illusion. Reality lay "yonder" in a solitary perfect being, *The One,* the source of all truth, goodness, and beauty. He said pure souls may hope to "return" there. Sometimes this return occurred as a mystical vision. Plotinus believed he had experienced such a vision.

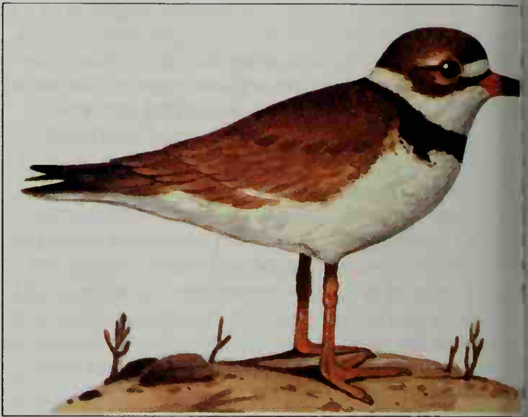
Plotinus may have been born in Egypt. He joined a military campaign to the East to try to learn more about Indian philosophy. Plotinus spent the last years of his life teaching in Rome. He disliked writing but dictated 54 lectures in six 9-lecture sets called the *Enneads.* His pessimism reflects only one side of Plato's philosophy—that in which philosophy is seen as a consolation or as an escape from the world. But this was the side most appealing to Romans of Plotinus's time. S. Marc Cohen

Plovdiv, *PLAWV dihf* (pop. 341,058), is Bulgaria's second largest city. Only Sofia has more people. Plovdiv is an agricultural, industrial, and railroad center. It lies on the Maritsa River (see **Bulgaria** [map]).

Plovdiv is Bulgaria's chief marketing center for tobacco and perfume. It has leather, metal, and textile industries, and it processes farm products. Plovdiv holds a major international trade fair twice a year.

By the 400's B.C., a Thracian town existed at what is now Plovdiv. Philip of Macedonia captured it in 341 B.C. From about the time of the birth of Christ until about A.D. 300, the town flourished as part of the Roman Empire. It later changed hands many times before the Ottoman Empire captured it in 1364. In 1878, Plovdiv became capital of Eastern Rumelia, a partly self-governing province in the Ottoman Empire. It united with the rest of Bulgaria in 1885. Vojtech Mastny

Plover, *PLUHV uhr* or *PLOH vuhr,* is the name of a group of shore birds found throughout the world. Plovers measure from 6 to 16 inches (15 to 41 centimeters) in length. They may be many colors, and the feathers are usually marked in various patterns. The head and neck often have dark markings. The wings are pointed and reach beyond the end of the tail.



WORLD BOOK illustration by John F. Eg

The semipalmated plover nests along shorelines in Alaska and Canada. It winters as far south as central Chile and Argentina. The bird is also known as the *ring-necked plover.*

A plover has a short, thick neck and a short bill. Unlike most other shore birds, plovers secure their food from the surface of the ground rather than by probing. Their food includes such animals as insects, worms, ar crabs. They also eat berries.

Plovers build their nests on the ground. The female plover usually lays four eggs. The spotted eggs are diffi cult to distinguish from pebbles around them. Feathers of newly hatched chicks are also marked with dark spots.

About 12 species of plovers live in North America. Two common species, the *black-bellied plover* and the *lesser golden-plover,* nest in arctic Alaska and Canada. The black-bellied plover has black and white feathers and a black breast and throat. Feathers of the lesser golden-plover are black and gold. This bird migrates as far as Hawaii and South America in winter.

The *semipalmated plover,* or *ring-necked plover,* als nests in Alaska and Canada. It has a dark back, a white breast, and a black band across its neck. It winters as fa south as central Chile and Argentina. Other common North American plovers include the *snowy plover,* the *Wilson's plover,* the *mountain plover,* and the *killdeer.* The *piping plover* was once common on the Atlantic and Gulf coasts and along the Great Lakes. This species is now in danger of extinction. Fritz L. Knopf

Scientific classification. Plovers belong to the family Char driidae. The scientific name for the black-bellied plover is *Pluvi alis squatarola.* The lesser golden-plover is *P. dominica.* The semipalmated plover is *Charadrius semipalmatus,* and the piping plover is *C. melodus.*

See also **Animal** (picture: Animals of the polar regions); **Bird** (pictures: Birds of the Arctic; Birds of the seacoasts); **Killdeer.**

Plow is a tool that is used to prepare soil for planting. plow digs into the ground and pushes, cuts, and lifts th soil to break it up. Much of the food in the world come from crops that have been grown in plowed fields and

m food-producing animals that feed on such crops.

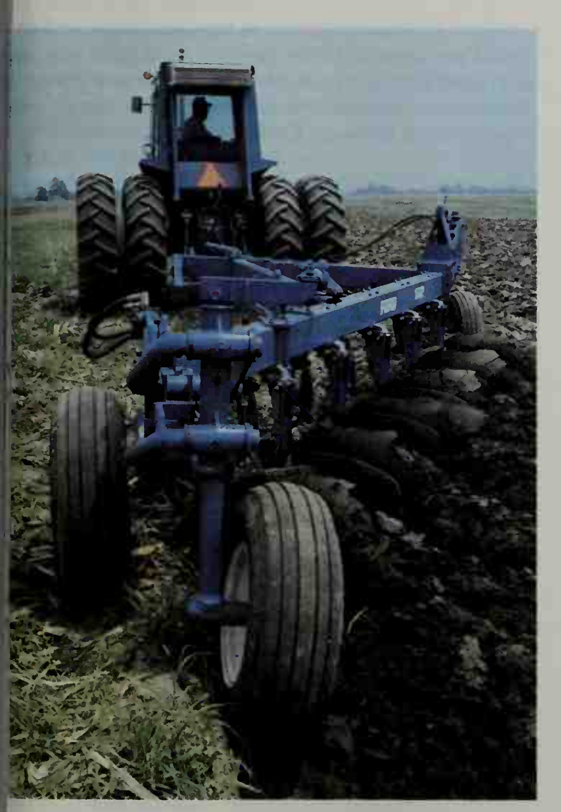
armers *till* (plow) the soil for many reasons. For ex-
ple, plowing reduces the hardness of the upper 6 to
nches (15 to 41 centimeters) of the earth's crust, mak-
seed planting easier. Tillage also aids planting by
ering up the *residue* (remains) of the previous crop
l by killing weeds and insects. In addition, air move-
nt into the earth increases, and oxygen can act more
ckly on organic matter in the soil to speed the re-
se of plant nutrients. Plants growing in the soil can
 take in more oxygen through their roots and thus
w more rapidly.

Kinds of plows

There are four chief kinds of plows: (1) the *tractor*
w, (2) the *walking plow,* (3) the *sulky plow,* and (4) the
g plow. In developed countries, almost all farmers
 a tractor plow. Most farmers in developing coun-
s use a walking plow. Sulky plows and gang plows
e almost disappeared from use. Practically all plows
d today are made of iron and steel, but some are
ilt of wood.

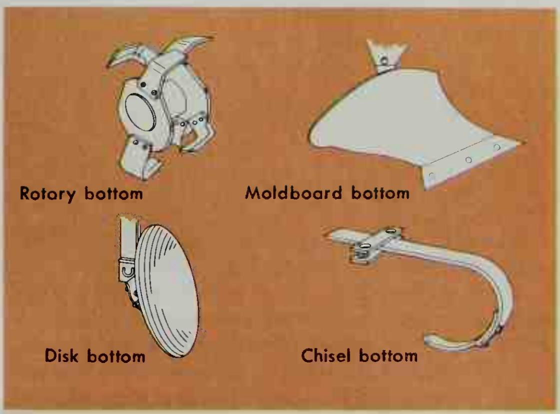
The tractor plow is pulled by a tractor. This type of
w has from 1 to 10 or more *bottoms* (furrowing
des) mounted on its frame. *Colters* (disk blades) can
o be mounted on the frame to cut residue.

The walking plow is pulled by horses, mules, or
n. The farmer must walk behind and hold the han-
s to guide the plow.



Ford Motor Company

ractor plow is pulled by a tractor. The plow shown above
 seven furrowing spades, called *bottoms.* It uses *moldboard*
ttoms, the most popular type of plow bottom.



WORLD BOOK illustration

Plow bottoms are manufactured in four main designs. The *rotary bottom* mixes crop residue with the soil. The *moldboard bottom* buries residue. The *disk bottom* tills hard, sticky, or stony land. The *chisel bottom* leaves residue on the surface.

The sulky plow has a seat and wheels, and so the farmer can ride while tilling. Horses pull the sulky plow, which was invented in 1875 by John Deere, an Illinois blacksmith.

The gang plow, a horse- or tractor-drawn plow, also allows the farmer to ride while tilling. It has two or more bottoms and three wheels. A gang plow can till as many furrows at a time as it has bottoms. A walking plow and a sulky can till only one at a time.

Kinds of plow bottoms

Farmers also classify plows according to the types of bottoms they have. There are four main kinds of plow bottoms: (1) the *moldboard,* (2) the *disk,* (3) the *chisel,* and (4) the *rotary.*

The moldboard plow bottom ranks as the most widely used type. A moldboard plow *molds* (covers and buries residue) as it tills. The moldboard bottom has three main parts: (1) the *share,* (2) the *landside,* and (3) the *moldboard.* They are bolted onto a frame called the *frog,* which holds them together in the shape of a three-sided wedge.

The share is the sharp edge that cuts the furrow slice loose from the ground. The share uses most of the power that is required to pull the plow bottom through the soil.

The landside fits behind the point of the share and below the moldboard. It slides along the land at the bottom of the furrow, where a slice of soil has been cut out, and stabilizes the plow.

The moldboard is located above and to the rear of the share. It turns the soil, breaks it up, and moves it to one side.

Farmers use four types of moldboards. A *stubble* moldboard is short and sharply curved. This type may be used for slow plowing in soils that *scour* (slide cleanly off the moldboard). A *general-purpose* moldboard has a longer curve, which makes it useful for average scouring conditions and plowing speeds. A *high-speed* moldboard has an even longer curve and can plow at higher speeds without throwing the soil too far to the side. A *slatted* moldboard consists of long



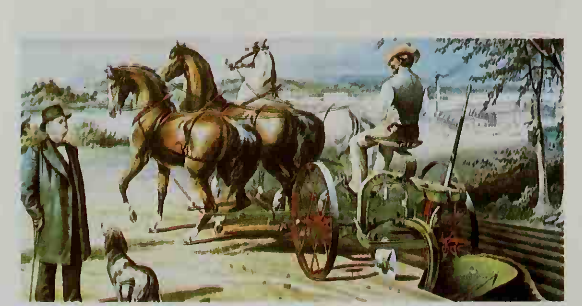
Giraudon/Art Resource

Egyptian farmers tilled their fields with wooden walking plows in 1300 B.C. They used oxen to pull the plows.



Detail of *American Farm Scenes #1: Spring* (1853), a hand-colored litho-graph by Frances Palmer, printed by Nathaniel Currier (Granger Collecti

The American farmer in 1853, like the ancient Egyptians, use a plow pulled by oxen. But this plow had a steel bottom.



John Deere

The sulky plow allowed farmers to ride while they plowed. John Deere, an Illinois blacksmith, invented this plow in 1875.



J. I. Case Compa

Steam-powered plows came into use in the early 1900's. Such machines were costly and hard to repair.

curved steel slats, which provide little surface area for sticky soils to cling to.

Other types of bottoms provide greater efficiency than moldboards in certain situations. The bottom of a *disk plow* consists of a disk-shaped blade designed to till hard, sticky, or stony land. The *chisel plow* has narrow, C-shaped bottoms. Chisel plows lift the soil without turning it over. This action leaves crop residue on the surface where it can reduce the *erosion* (wearing away) of soil that results from the movement of wind and water. A *rotary plow* has many bent rotating blades that mix residue with the soil.

History

The people of most prehistoric civilizations never tilled the soil. They merely punched holes in the ground with a stick to bury the seed and hide it from birds and rodents. Then, more than a million years ago, people discovered that plants grew better in soil that had been loosened. They began to use such objects as sharp sticks, rocks, bones, or shells to pry loose chunks of dirt before planting the seed.

The first plow was made about 8,000 years ago. A farmer sharpened one prong of a forked branch to turn the soil and probably hitched a person to the other prong. The farmer guided the implement by holding the branch's stump while the other person pulled. Later, oxen were used to pull the plow, and a pointed iron spade replaced the bottom prong. Ronald T. Schuler

See also **Deere, John; Farm and farming** (picture: Tillage and planting equipment).

Plum is a popular fruit that is eaten fresh or used to make jams, jellies, and preserves. Some types of plums are dried to make prunes (see **Prune**).

Plums grow on trees that range in height from 7 to 1 feet (2 to 5 meters). Plums have a smooth, thin skin surrounding a thick, juicy flesh. A hard pit in the center of the fruit contains one or two seeds. Plums may be hear shaped, oval, or round. Cultivated varieties measure

Kinds of plums

The three main kinds of plums are European, Japanese, and American. European plums are the most widely grown. Japane plums are firm and juicy. American plums are hardy and can grow in colder climates than European and Japanese plums.

WORLD BOOK illustrations by James Teas



f m 1 to $2\frac{1}{2}$ inches (25 to 64 millimeters) in diameter. ley may be black, blue, green, purple, red, or yellow, pending on the variety.

About $6\frac{1}{2}$ million short tons (6 million metric tons) of ims are produced in the world each year. The leading im-producing countries include China, Germany, and United States. The United States produces about 1 llion short tons (9 million metric tons) of plums each ir. California produces far more plums than all the ier states combined. In Canada, British Columbia and tario are the leading plum-growing provinces.

Kinds of plums. There are three main kinds of ıms: (1) European, (2) Japanese, and (3) American. ere are several *cultivars* (cultivated varieties) within ch type.

European plums, often called *domesticas,* originated southwestern Asia, but they have been grown in Euoe for more than 2,000 years. In the 1600's, European ıms were introduced into what is now Massachusetts. the 1700's, Spanish missionaries brought them to Calinia. Important cultivars include Bradshaw, Grand ke, Jefferson, Lombard, Reine Claude, and Stanley. rtain cultivars of European plums with high sugar ntent are primarily dried to make prunes.

Japanese plums are native to China, but they were st cultivated in Japan. In 1885, Luther Burbank, an nerican horticulturist, introduced them into California. panese plums are generally firm and juicy and are ually eaten fresh. Cultivars include Abundance, Burnk, Santa Rosa, and Shiro.

American plums grow on trees that were developed om wild plum trees of North America. The trees are t widely cultivated, but they can survive in much lder climates than European and Japanese plum trees n. Cultivars of American plums include Cheney, De to, Golden Beauty, and Monitor.

Growing plums. Growers produce plum trees by atching buds of commercially desirable cultivars onto a *otstock* (root system and stem from another plant). Tother they make a sturdier tree (see **Grafting**). For exnple, several species of American plum trees are usel as rootstocks for European and Japanese plums. owers plant plum trees about 20 feet (6 meters) apart id carefully prune them during the first few years of owth to form well-shaped trees.

Plum trees generally flower from one to five years ter planting. They produce beautiful white blossoms in e early spring that, if pollinated, develop into mature uit by late summer. Most cultivars of plum trees are *lf-unfruitful*—that is, they cannot produce fruit with eir own pollen and must be pollinated by another culvar within the same type. Both wild bees and bees om beehives that growers place in their orchards are portant for carrying pollen from tree to tree.

Diseases and pests. Major diseases that infect plum ees include the fungal diseases *black knot* and *brown t.* Growers control these diseases by removing and estroying infected parts of the trees, or by spraying the ees with fungicides. *Plum curculio* is a serious insect est that damages the fruit by laying eggs underneath e skin. This pest is controlled through the use of insecide sprays.

Scientific classification. Plums belong to the rose family, saceae. They are genus *Prunus.* The scientific name for the species to which European plums belong is *P. domestica.* Japanese plums are *P. salicina.* American plums are of several species, including *P. americana, P. nigra,* and *P. besseyi.*

James E. Pollard

See also **Drupe**; **Prune**; **Fruit** (table: Leading fruits in the United States).

Plumbago, *pluhm BAY goh,* also called *leadwort,* is the name of several garden plants and shrubs grown for their clusters of blue, white, or reddish-purple flowers. The flaring petals of each flower are joined at the center to form a long tube. The leaves are oval, shiny, and dark green. A species planted yearly in many northern gardens grows up to $1\frac{1}{2}$ feet (46 centimeters) high and has spikes of blue flowers. A shrubby species called *cape leadwort* grows in southern California and the Gulf States. It forms bushes or vines and is covered by blue or white flowers for much of the year. In northern states, the cape leadwort grows only in greenhouses.

Scientific classification. Plumbagos belong to the plumbago or leadwort family, Plumbaginaceae. The scientific name for the annual plumbago is *Plumbago caerulea;* the cape leadwort is *P. auriculata.* Walter S. Judd

Plumbing is a system of pipes that carries water into and out of a house or other building. The term comes from the Latin word *plumbum,* meaning *lead.* The ancient Romans used lead plumbing pipes. Today, most plumbing pipes are made of brass, cast iron, copper, plastic, or steel.

A plumbing system consists of two separate sets of pipes, a *water supply system* and a *drainage system.* The water supply system brings clean water to plumbing fixtures, including bathtubs, showers, sinks, and toilets. It also supplies clean water to such appliances as dishwashers, garbage disposers, hot-water heaters, washing machines, and water softeners. The drainage system carries away water and waste materials.

The water supply system and the drainage system both must function properly for a building's plumbing to be efficient and safe. Defects in a water supply system, such as leaking connections or dripping faucets, can cause damage to the system and waste a large amount of water. A drainage system that leaks or overflows creates a health hazard by spilling waste materials and the bacteria they contain.

The water supply system. Water for a plumbing system comes from two sources: (1) rivers and lakes, and (2) wells. Cities and towns draw water from these sources and pipe it to treatment plants, where it is purified. The purified water flows through large pipes called *mains,* which run under the streets. The mains connect with smaller pipes known as *service lines,* which lead into each building. In some rural and suburban areas, many houses and other buildings have private wells. See **Water** (City water systems).

The water supply system of every building has a *shutoff* valve. The shut-off valve normally remains open, permitting water to enter the building. The valve can be closed to turn off the water in order to repair the pipes or fixtures or in case of some other emergency. Each plumbing fixture and appliance also should have its own shut-off valve.

In many plumbing systems, a *water meter* attached to the service line measures the amount of water that is used in the building. The water company charges the

customer according to the amount of water used.

Water that flows into a building through the service line is cold. Pipes connected to the service line carry the water to all the plumbing fixtures and to the appliances that use cold water. One of the pipes brings water to the hot-water heater. Water enters the hot-water heater through a *cold-water inlet pipe.* The water is heated in a tank to a temperature of 120 °F to 150 °F (49 °C to 66 °C). The heated water is drawn from the top of the tank. It flows through a *hot-water outlet pipe* and is carried by branch pipes to the plumbing fixtures and appliances in the building that use hot water. The hot-water heater tank in most houses holds from 30 to 50 gallons (114 to 189 liters) of water. The tank is always full. As hot water is used, cold water enters the tank at the bottom to be heated.

The water in a plumbing system's water supply pipes is always under pressure, even when it is not running. The fixtures and appliances have valves that hold back the water until it is needed. When the fixture or appliance is turned on, the valve lets water flow in. The valve stops the flow of water when the fixture or appliance is turned off.

The drainage system. After water has been used, it flows out of the building through the pipes of the drainage system. This system also carries away solid waste from sinks, toilets, garbage disposers, and other fixtures and appliances. The pipes of the drainage system are larger than the pipes of the water supply system in order to prevent them from becoming clogged with solid materials.

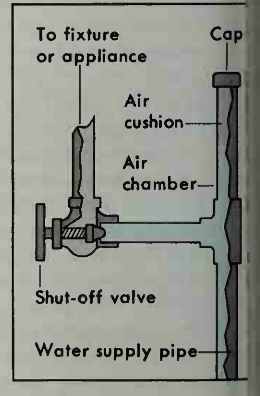
The drainpipes from the fixtures and appliances slar downward, carrying water and sewage to a vertical pi called the *soil stack.* The soil stack empties into a main drain beneath the building. This drain leads to a sewer or septic tank outside the building. The top of the soil stack extends up through the roof of the building, whe air enters the opening, or *vent,* in this pipe. The air flov through the soil stack into a network of *revent pipes.* The revent pipes lead into the drainpipes of the fixture that are not near the soil stack. Most toilets are close tc the soil stack, and so their drainpipes are connected di rectly to it.

The flow of air into the drainage system prevents a partial vacuum from developing in the pipes as water and sewage flow out. Such a vacuum would slow the passage of water and sewage from the drainage systen In some plumbing systems, the revent pipes extend through the roof of the building instead of leading to the soil stack.

The soil stack and revent pipes also perform another important function. The drainpipe of each plumbing fix ture and appliance empties through a U- or S-shaped bend that is called a *trap.* Water is held in the trap whe ever the fixture or appliance is not being used. The water in the trap serves as a seal that prevents harmful gases from the sewer or septic tank from entering the building through the fixtures or appliances. Instead, the

A home plumbing system All plumbing systems have a water supply system and a drainage system. The water supply system brings clean water to plumbing fixtures and appliances. The drainage system has drainage pipes that carry away water and waste materials. Venting pipes keep air flowing through the system.

WORLD BOOK diagrams by Steven Li



An air chamber, *above,* con nects to pipes that lead to fix tures or appliances. A cushio of air inside the chamber ab- sorbs the force of incoming water after a faucet or valve i closed quickly. Without an ai chamber, the pipes would vi brate and make a hammering noise just after the water is shut off.

ises escape through the soil stack and revent pipes.
Many traps have a *cleanout plug* that can be removed the pipe becomes clogged. A long, flexible tool called *drain auger,* or *snake,* can then be inserted into the pe to clear it. Cleanout plugs are also located at other oints throughout a drainage system. Almost all plumbg systems have a cleanout plug where the soil stack onnects to the main drain of the building.

In many communities, sewage flows from the main rain of each building into an underground system of pes that carries it to a *sewage treatment plant.* The ant treats the sewage water and reduces the bacteria it. The water can then be poured into a river or other ody of water with minimum damage to the waterway.

Many rural and suburban areas do not have a public ewerage system. There, the sewage from a building ows into a septic tank nearby. Bacteria in the septic nk break down most of the solids in the sewage into as and a harmless substance called *humus.* The gas escapes into the air, and the humus is removed periodially. The liquids run out of the tank into the surroundig soil. See **Sewage**.

How faucets work. The flow of water is regulated by ucets in bathtubs, showers, sinks, and other principal inds of plumbing fixtures except toilets. Faucets are lso called *taps.*

There are two main kinds of faucets, *washer-type faucets* and *washerless faucets.* Most washer-type faucets ave two handles, one for hot water and one for cold. he water comes out of a single spout. Older washerype faucets have a separate handle and spout for hot nd cold water.

In a washer-type faucet, water is turned on and off by urning one or both of the handles. A threaded *stem* is ttached to each handle and screws into the faucet. At he bottom of each stem is a washer made of rubber or f synthetic fibers. When the faucet is turned off, the tem and washer are held tightly over a *valve seat* at the op of the water supply pipe. The washer prevents the low of water into the faucet. When the faucet is turned n, the stem is unscrewed enough to lift it and the vasher off the seat. Water can then flow into and hrough the spout.

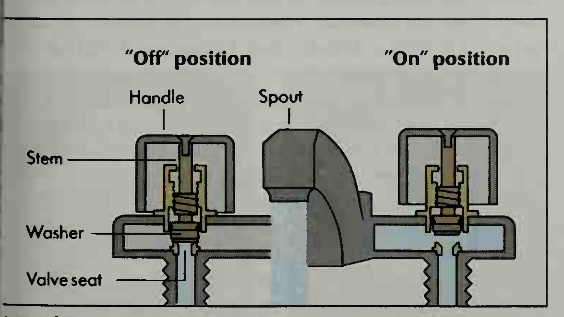
Washerless faucets have either two handles or one, nd most have a single spout. In a washerless faucet vith two handles, water is turned on and off the same way as in washer-type faucets. In most single-handle washerless faucets, water is turned on by lifting the handle and is turned off by pressing the handle down. The temperature of the water is regulated either by turning the handle or by moving it from side to side.

Attached to the handle of a typical washerless faucet is a disk or some other device with several holes in it. This disk fits over another disk. The two disks have the same number of holes, and all the holes are the same size. When the faucet is turned off, the position of the top disk changes so that the disk covers the holes of the bottom disk. Water cannot flow into the faucet when the top disk is in this position. When the faucet is turned on, the holes of the two disks are lined up with one another, enabling water to flow through them and into the spout.

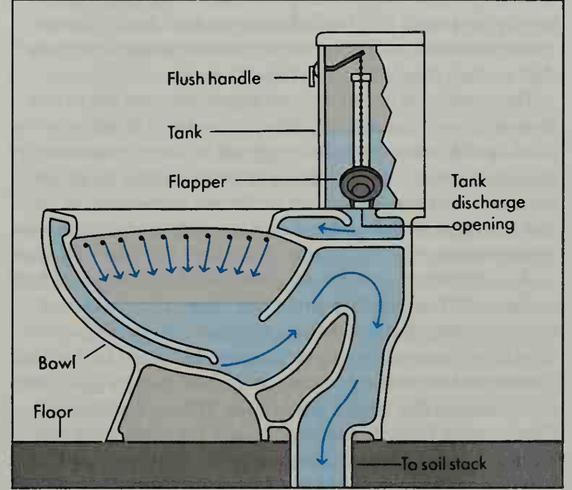
How toilets work. Most toilets consist of a *bowl* and a *tank,* both of which contain water. When a toilet is flushed, water rushes from the tank through a *tank discharge opening* and into the bowl. The rushing water carries the contents of the bowl through the trap of the toilet to the soil stack. The bowl and tank refill with water from a water supply pipe, and the toilet is ready to be flushed again.

When the tank of the toilet is full, a *stopper ball* or a *flapper* covers the tank discharge pipe. The ball or flapper prevents water from running out of the tank before the toilet is flushed. To prevent more water from entering the tank, an *inlet valve* covers the opening of the water supply pipe. Attached to the inlet valve is a device called a *float.* The float rides on the water.

When a toilet is flushed, the action of pushing down the handle lifts the stopper ball or flapper from the tank discharge opening. The ball or flapper floats on the water rushing through the opening in the pipe. As the level of the water goes down, so does the level of the float. The lowering of the float opens the inlet valve, and more water enters the tank through a *filler tube.* But water continues to flow from the tank until the level falls below the tank discharge opening. The stopper ball or

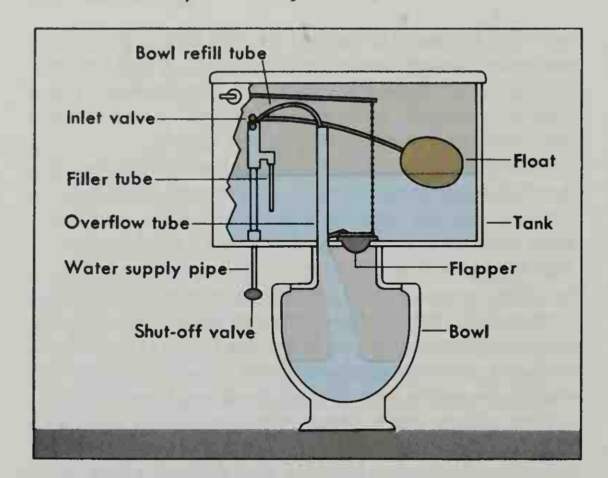


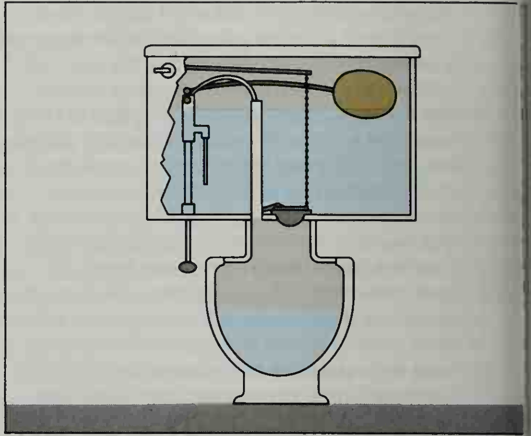
A washer-type faucet has a threaded *stem* attached to each of its handles. At the bottom of each stem is a washer. When the water is turned off, the stem and washer are held tightly over a *valve seat* at the top of the water supply pipe. When the water is turned on, the stem and washer are held off the seat.



WORLD BOOK diagrams by Steven Liska

Flushing a toilet lifts a *flapper* off the *tank discharge opening,* enabling water to rush into the *bowl.* The water carries the bowl's contents into the drainpipe and to the soil stack. When the tank is nearly empty, the flapper drops down.





WORLD BOOK diagrams by Steven I

A toilet refills after the water has run out of the tank. The *float* lowers with the water, opening the *inlet valve* over the water supply pipe. Water then enters the tank through a *filler tube.* Water also goes into a *bowl refill tube* and enters the bowl through an *overflow tube.* The float rises with the level of the water in the tank, *above left.* When the tank and bowl are full, the float causes the inlet valve to close over the water supply pipe, *above right,* and stop the flow of water.

flapper then drops onto the tank discharge opening, and water from the filler tube refills the tank.

Some of the water from the filler tube goes into a *bowl refill tube.* It then flows into an *overflow tube* and washes down the sides of the toilet bowl. As the level of water in the tank rises, so does the level of the float. The float rises until the water is about an inch (2.5 centimeters) from the top of the overflow tube. Both the tank and the bowl have now been refilled. The inlet valve closes over the opening of the water supply pipe, and the water is shut off.

History. The earliest plumbing systems disposed of human wastes. In the Indus Valley in what are now Pakistan and western India, most dwellings had drains for waste disposal by about 2500 B.C. A palace built on the island of Crete about 2000 B.C. had pipes that supplied drinking water. It also had primitive toilets and a drainage system with air shafts that served as vents. The ancient Romans developed faucets and a sewerage system that carried waste into rivers and streams.

The quality of plumbing declined after the fall of the Roman Empire in western Europe in the A.D. 400's. In the Middle Ages, people disposed of waste materials by throwing them into the street. A type of flush toilet was developed in the 1500's. But it did not come into wide use because of the general lack of plumbing and sewerage systems. In 1778, Joseph Bramah, an English cabinetmaker, patented an improved flush toilet. In the first half of the 1800's, toilets became common in England. But most of them drained into pits called *cesspools,* which often overflowed. Septic tanks were invented in the mid-1800's, and a modern sewerage system began operating in London in the 1860's. Also in the 1860's, Sir Thomas Crapper, an English plumber, made improvements in the flush toilet patented by Bramah. Evan Powell

Plunkett, Edward John Moreton Drax. See Dunsany, Lord.

Plural. See Number (in grammar).

Pluralism. See Government (Pluralism); Minority group.

Plutarch, *PLOO tahrk* (A.D. 46? - A.D. 120?), a Greek biographer and essayist, became famous for his work, *Parallel Lives of Illustrious Greeks and Romans.* Plutarch wrote these biographies in pairs, each comparing one Greek and one Roman statesman or general. The comparisons are often forced, but the *Lives* constitute an important source of historical information. Twenty-three pairs of the *Lives* have survived.

Plutarch's Lives became the basis of many stories and poems of the Middle Ages. William Shakespeare and other Elizabethan dramatists used a brilliant translation of the *Lives* by Sir Thomas North for material for many of their historical plays. The *Lives* contains sharply drawn character sketches and lively historical descriptions of Greece and Rome.

Plutarch also wrote essays and dialogues on historical, rhetorical, and philosophical topics collected under the title *Morals.* Among them is a curious account of *The Face on the Moon.*

Plutarch was born at Chaeronea, in Boeotia, Greece, near the homes of Hesiod and Pindar. He studied philosophy in Athens and later lectured on this subject in Rome. In travels through Greece, Italy, and Egypt, he spent much time studying and collecting facts on the men of whom he wrote. He returned to Boeotia as a priest of Apollo at Delphi, and it is believed that he wrote his great works there. Cynthia W. Shelmerdine

Pluto, *PLOO toh,* is the most distant planet from the sun. Pluto and Neptune are the only planets that cannot be seen without a telescope. Astronomers "discovered" both these planets by using mathematics.

Pluto is about 39 times as far from the sun as Earth is. Its mean distance from the sun is about 3,666,200,000 miles (5,900,100,000 kilometers). Pluto travels around the sun in an *elliptical* (oval-shaped) orbit. At some point in its orbit, it comes closer to the sun than Neptune, usually the second farthest planet. It stays inside Neptune's orbit for about 20 earth-years. This event occurs every 248 earth-years, which is about the same number of earth-years it takes Pluto to travel once around the sun.

uto at a glance

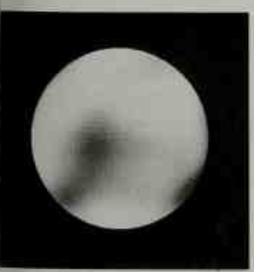
istance from the sun: *Shortest*—2,749,600,000 mi. 425,100,000 km); *Greatest*—4,582,700,000 mi. (7,375,100,000 km); *lean*—3,666,200,000 mi. (5,900,100,000 km).
istance from the earth: *Shortest*—2,670,000,000 miles 290,000,000 kilometers); *Greatest*—4,670,000,000 miles 520,000,000 kilometers).
iameter: 1,430 miles (2,300 kilometers).
ength of year: About 248 earth-years.
otation period: About 6 earth-days.
emperature: About −390 to −370 °F (−230 to −220 °C).
tmosphere: Methane.
atellites: 1.

uto last entered Neptune's orbit on Jan. 23, 1979, and emained there until Feb. 11, 1999. As it orbits the sun, uto spins on its axis, an imaginary line through its cen-er. It spins around once in about six earth-days.

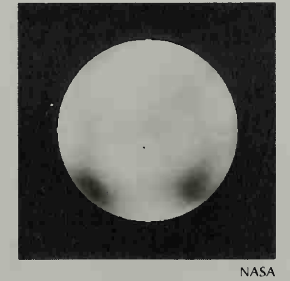
Astronomers know little about Pluto's size or surface onditions because it is so far from Earth. Pluto has an stimated diameter of about 1,430 miles (2,300 kilome-ers), less than a fifth that of Earth. Pluto's surface is one f the coldest places in our solar system. Astronomers elieve the temperature on Pluto may be about −390 to −370 °F (−230 to −220 °C). The planet appears to be artly covered with frozen methane gas and to have a hin atmosphere composed mostly of methane. Because luto's density is low, astronomers think Pluto is mainly cy. Scientists doubt Pluto has any form of life.

Many astronomers do not consider Pluto to be a plan-t. They have two reasons for their belief: (1) Pluto does ot resemble any of the four planets that are closest to t—Neptune, Uranus, Saturn, and Jupiter. Pluto is small nd icy, and the other four are huge and gaseous. (2) Plu-o resembles *Kuiper belt objects* (KBO's), bodies that ave been discovered beyond Pluto's orbit. All the KBO's ever found are smaller than Pluto, so the astronomers onsider Pluto to be merely the largest known KBO.

In 1905, Percival Lowell, an American astronomer, ound that the force of gravity of some unknown planet eemed to be affecting the orbits of Neptune and Ura-nus. In 1915, he predicted the location of a new planet nd began searching for it from his observatory in Flag-staff, Arizona. He used a telescope to photograph the rea of the sky where he thought the planet would be ound. He died in 1916 without finding it. In 1929, Clyde W. Tombaugh, an assistant at the Lowell Observatory, used predictions made by Lowell and other astrono-mers and photographed the sky with a more powerful, wide-angle telescope. In 1930, Tombaugh found Pluto's image on three photographs. The planet was named after the Roman god of the dead. The name also honors Percival Lowell, whose initials are the first two letters of *Pluto*. In 1978, astronomers at the U.S. Naval Observatory substation in Flagstaff detected a satellite of Pluto. They named it Charon. This satellite has a diameter of 737 miles (1,186 kilometers).



NASA



NASA

Pluto is so far from Earth that even powerful telescopes reveal little detail of its surface. The Hubble Space Telescope gathered the light for these pictures of Pluto.

In 1996, astronomers published the first detailed im-ages of Pluto's surface. The images, taken by the Hubble Space Telescope, show about 12 large bright or dark areas. The bright regions, which include polar caps, are probably frozen nitrogen. The dark areas may be meth-ane frost that has been broken down chemically by ul-traviolet radiation from the sun. Hyron Spinrad

See also **Lowell, Percival; Planet; Solar system.**

Pluto, *PLOO toh,* was the god of the dead in Roman mythology. The Romans sometimes called him *Dis Pater* or *Orcus*. Pluto was almost identical to Hades, the Greek god of the dead. The Romans borrowed and preserved without change almost all the myths about Hades and his underworld kingdom. Some scholars believe the Ro-mans had no god of the dead before they came into contact with Greek culture in the 700's B.C. The name *Pluto* comes from *Pluton,* an alternate Greek name for Hades. See also **Hades; Persephone.** Daniel P. Harmon

Plutonium, *ploo TOH nee uhm,* is a radioactive metal-lic element. Almost all plutonium is produced artificially. Only an extremely small amount of it occurs naturally. Plutonium has a variety of scientific and industrial uses. Its chemical symbol is Pu, and its atomic number is 94 (see **Atom** [The atomic number]). Plutonium melts at 640 °C and boils at 3460 °C. At 20 °C, it has a density of 19.86 grams per cubic centimeter (see **Density**).

Plutonium is highly poisonous because it rapidly gives off radiation in the form of high-energy alpha par-ticles (see **Alpha particle**). These particles may cause cancer or other serious health problems. In addition, plutonium is extremely explosive. It must be kept in quantities smaller than a *critical mass,* the amount at which it would explode spontaneously.

Scientists have discovered 15 isotopes of plutonium. These isotopes have mass numbers 232 through 246. The most important isotope is Pu-239, which readily un-dergoes *fission* when struck by a neutron. In fission, the nucleus of an atom is split into two nearly equal parts, and energy is released. Pu-239 is a source of energy in nuclear reactors and nuclear weapons. Scientists pro-duce Pu-239 by bombarding uranium 238 with neutrons. The same process forms Pu-239 as a waste product in nuclear reactors that use uranium as the basic fuel. The disposal of waste Pu-239 has become a serious problem because of its relatively long *half-life* of 24,100 years.

Plutonium has various other applications. For exam-ple, Pu-238 powers heart pacemakers, certain instru-ments on spacecraft, and some other devices. Pu-242 and Pu-244 are useful in studying chemicals and metals.

Plutonium was discovered in 1940 by four American scientists—Glenn T. Seaborg, Edwin M. McMillan, Joseph W. Kennedy, and Arthur C. Wahl. They produced Pu-238 by bombarding uranium 238 with *deuterons,* the nuclei in atoms of *deuterium,* an isotope of hydrogen. The most stable plutonium isotope, Pu-244, was discov-ered in nature in 1971. J. Rayford Nix

See also **Nuclear energy; Transuranium element.**

Plymouth, *PLIHM uhth,* is a historic seaport on the southwest coast of England. It is the chief city in the district of Plymouth, which has a population of about 253,400. The city lies on Plymouth Sound, an inlet of the English Channel and one of the world's finest natural harbors (see **England** [political map]).

The site of a naval dockyard, Plymouth was the target of German bombing raids during World War II (1939-1945). Much of the center of the city was destroyed by the raids. The center has since been rebuilt in a modern style. Parts of Plymouth escaped serious damage and have buildings that are hundreds of years old. The city's chief industries include engineering and the manufacture of clothing and electronic goods.

In the late 1500's, Sir Francis Drake and other English explorers set sail from Plymouth. The *Mayflower,* the ship that carried the Pilgrims to North America in 1620, also sailed from Plymouth. Peter R. Mounfield

Plymouth, *PLIHM uhth,* Massachusetts (pop. 51,701), is often called *America's Hometown.* In 1620, colonists from England sailed across the Atlantic on the *Mayflower* and settled in Plymouth. Plymouth was the second permanent English settlement in America. Jamestown, Virginia, was the first. Plymouth lies on a harbor, about 40 miles (64 kilometers) south of Boston (see **Massachusetts** [political map]). Plymouth Rock lies near the spot where the colonists are believed to have landed (see **Plymouth Rock**). Plimoth Plantation, a re-creation of the original settlement, features *Mayflower II,* built the way the original *Mayflower* is believed to have looked (see **Mayflower** [picture: *The Mayflower II*]). Many tourists visit Plymouth, and the town's economy is based on tourism. The processing of cranberries is also an important economic activity in the area. The Pilgrim 1 nuclear power plant is located in Plymouth. Laurence A. Lewis

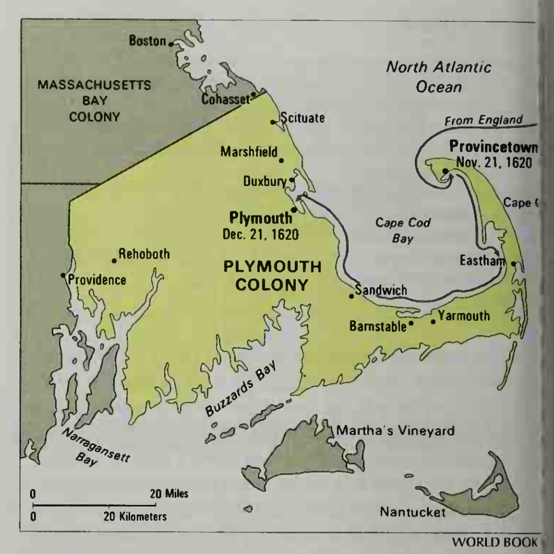
Plymouth Colony, *PLIHM uhth,* was the second permanent English settlement in America. The colonists who settled there became known as *Pilgrims* because of their wanderings in search of religious freedom. In 1620, they established their colony on the rocky western shore of Cape Cod Bay in southeastern Massachusetts. This region had been called *Plimouth* on John Smith's map of New England, drawn in 1614. The Pilgrims established the Congregational Church in America. Plymouth Colony remained independent until 1691, when it became part of Massachusetts Bay Colony.

Plymouth Colony and the Pilgrims have become for all Americans a lesson of how a people with little more than courage, perseverance, and hard work could build themselves a home in a hostile world. Their bravery set an example for future generations of Americans.

Many tourists visit modern Plymouth with its memorials to the Pilgrim forefathers. Just south of town there is a model of the original Pilgrim village. Plimoth Plantation, Inc., a nonprofit organization dedicated to the preservation of the Pilgrim heritage, also maintains a replica of the first Pilgrim house and of the *Mayflower.*

The founding of Plymouth Colony

Most of the Pilgrims were *Separatists* (Puritans who had separated from the Church of England). The government of England arrested and tried the Separatists because of their *nonconformity* (refusal to belong to the Church of England). In 1608, a group of Separatists



Plymouth Colony was founded in 1620 by Pilgrims who saile from England aboard the *Mayflower.* They first landed at Provincetown and later sailed around Cape Cod Bay to Plymouth. This map shows the extent of Plymouth Colony in 1630.

moved to the Netherlands. After a few years, some of them became dissatisfied, and felt that things would b better in a new land. They secured financial backing in London, and, in 1620, left the Netherlands in a small sh called the *Speedwell.* The ship stopped in England, an the expedition was joined by other English people wh hoped to better their lives. The group left England in th *Speedwell* and a larger ship, the *Mayflower.* The *Spee well* proved unseaworthy, and the fleet returned to En land twice. Finally, in September 1620, the *Mayflower* sailed alone from Plymouth, England. It carried 102 pas sengers, including women and children.

A rough passage of 65 days brought the *Mayflower* Cape Cod on November 20 (November 10, according t the calendar then in use). The Pilgrims had promised to settle somewhere within the limits of the original grant of the Virginia Company of Plymouth (see **Plymouth Company**). But errors in navigation led them to the Ne England region. Adverse winds and the shoals off Cape Cod forced the *Mayflower* to stay north. The ship anchored in Provincetown harbor inside the tip of Cape Cod on November 21.

The Pilgrim leaders were uncertain of their legal pos tion because they were in the area without authority. They also knew they would need discipline among themselves. To solve these problems, 41 men aboard the *Mayflower* met and signed the Mayflower Compac in which they agreed to form a government and to obe its "just and equal laws." The Pilgrims also elected John Carver as their governor.

The landing at Plymouth. The sea-weary Pilgrims were anxious to learn more about the country. For almost a month, several small groups explored the coast around Cape Cod Bay while the rest remained aboard. One of the groups had to take refuge on an island in Plymouth harbor during a blinding snowstorm. On Dec 21, 1620, this group landed at Plymouth. There they found a stream with clear water, some cleared land, an

ıigh hill that could be fortified. This site was once an dian village, but smallpox had wiped out all the Indi- ıs in 1617. The Pilgrims decided that this would be eir new home. The *Mayflower* sailed across Cape Cod ıy and anchored in Plymouth harbor on December 26.

The first year was a difficult one for the Pilgrims. ıor and inadequate food, strenuous work, and change- ıle weather made the settlers susceptible to sickness. ıe colony lost about half its members that first winter.

But help came one spring morning, when an Indian alked into the little village and introduced himself to e startled people as Samoset. He later returned with ıuanto. They introduced the Pilgrims to Massasoit, the *chem* (chief) of the Wampanoag tribe that controlled l southeastern Massachusetts. Carver and the chief ex- ıanged gifts and arranged a treaty of peace. Soon af- rward, the *Mayflower* sailed for England, leaving the lgrims. Then Carver died, and William Bradford be- ıme governor of the colony.

The Pilgrims, under Squanto's direction, caught *ale- ives* (a fish in the herring family) and used them as fer- lizer in planting corn, pumpkins, and beans. They unted and fished for food. The harvest that year led overnor Bradford to declare a celebration. Sometime ı the autumn of 1621, the Pilgrims invited their Indian iends to join them in a three-day festival that we now all the first New England Thanksgiving. The menu in- luded corn bread, duck, eel, goose, wild leeks, shell- sh, venison, watercress, and wine.

Life in Plymouth Colony

The Pilgrims received legal rights to settle at Plym- uth under a patent granted by the Council for New ngland in 1621. Governor Bradford received a new pat- nt, the Warwick Patent, in 1630. It granted him all the ınd south of a line between Narragansett Bay and Co- ıasset. Under this patent, Bradford could have claimed ıwnership of the entire colony, but he shared control with the other settlers. He turned the patent over to all the *freemen* (voters) of the colony in 1640. A few years later, surveyors marked off an area corresponding to the present counties of Bristol, Barnstable, and Plymouth as the colony of Plymouth.

Expansion of the colony. In November 1621, the ship *Fortune* arrived with 35 new colonists. Other ships brought additional settlers but the population grew to only 300 settlers in 10 years. Some of the colonists decided to move from Plymouth to better lands. Some went north and established the towns of Duxbury, Marshfield, and Scituate. Others moved west to Rehoboth, or farther east on Cape Cod to settle Sandwich, Barnstable, Yarmouth, and Eastham.

Government. The men who signed the Mayflower Compact were the freemen of the colony. They, along with any newly chosen freemen, met once a year to discuss the problems of the colony. This body, called the General Court, elected the governor and his assistants, made laws, and levied taxes. In outlying towns, the freemen held town meetings to elect their own officers and settle town matters. Beginning in 1639, these towns sent representatives to the General Court at Plymouth.

Economic life. The Pilgrims organized a joint-stock company with some London merchants to finance the voyage. The partnership was to last for seven years. The Pilgrims agreed to put the results of their labor into a common fund, which would provide the necessities of life for the settlers. At the end of seven years, all the profits and property were to be divided among the financiers and the settlers. This experiment did not work out, and in 1623 the colony allowed settlers to farm individual plots. The London merchants in 1627 agreed to sell their interest in the company to the Pilgrims, who finished paying off the debt in 1648.

The Pilgrims at first expected to make a profit from fishing. But they were never very successful at this. They turned to farming for their existence and to fur trading

An oil painting on canvas (about 1919); Smithsonian Institution, Washington, D.C. (Archives of 76, Bay Village, Ohio © J. L. G. Ferris)



A Thanksgiving feast was celebrated by the Pilgrims in 1621. They invited Indians who had helped them grow a plentiful harvest. The event is shown at the left in a painting by the American artist Jean Leon Gerome Ferris.

for profit. When other Puritans settled Massachusetts Bay Colony in 1628, the Pilgrims developed a prosperous trade in corn and cattle with them. Through steady and hard work, the colony was able to live moderately well without extremes of wealth or poverty.

The honored ones. William Bradford, the second governor of Plymouth, wrote a history of the Pilgrims' adventure aboard the *Mayflower.* He listed the ship's passengers as follows:

> Mr. John Carver; Kathrine, his wife; Desire Minter; & 2. man-servants, John Howland, Roger Wilder; William Latham, a boy; & a maid servant, & a child yt was put to him, called Jasper More.
>
> Mr. William Brewster; Mary, his wife; with 2. sons, whose names were Love & Wrasling; and a boy was put to him called Richard More; and another of his brothers. The rest of his childeren were left behind, & came over afterwards.
>
> Mr. Edward Winslow; Elizabeth, his wife; & 2. men servants, caled Georg Sowle and Elias Story; also a litle girle was put to him, caled Ellen, the sister of Richard More.
>
> William Bradford, and Dorothy, his wife; having but one child, a sone, left behind, who came afterward.
>
> Mr. Isaack Allerton, and Mary, his wife; with 3. children, Bartholmew, Remember, & Mary; and a servant boy, John Hooke.
>
> Mr. Samuell Fuller, and a servant, caled William Butten. His wife was [left] behind, & a child, which came afterwards.
>
> John Crakston, and his sone, John Crakston.
>
> Captin Myles Standish, and Rose, his wife.
>
> Mr. Christopher Martin, and his wife, and 2. servants, who were Salamon Prower and John Langemore.
>
> Mr. William Mullines, and his wife, and 2. children, Joseph & Priscila; and a servant, Robart Carter.
>
> Mr. William White, and Susana, his wife, and one sone, caled Resolved, and one borne a ship-board caled Perigriene; & 2. servants, named William Holbeck & Edward Thomson.
>
> Mr. Steven Hopkins, & Elizabeth, his wife, and 2. children, caled Giles, and Constanta, a doughter, both by a former wife; and 2. more by this wife, caled Damaris & Oceanus; the last was borne at sea; and 2. servants, called Edward Doty and Edward Litster.
>
> Mr. Richard Warren; but his wife and childeren were lefte behind, and came afterwards.
>
> John Billinton, and Elen, his wife; and 2. sones, John & Francis.
>
> Edward Tillie, and Ann, his wife; and 2. children that were their cossens, Henery Samson and Humillity Coper.
>
> John Tillie, and his wife; and Eelizabeth, their dougter.
>
> Francis Cooke, and his sone John. But his wife & other children came afterwards.
>
> Thomas Rogers, and Joseph, his sone. His other children came afterwards.
>
> Thomas Tinker, and his wife, and a sone.
>
> John Rigdale, and Alice, his wife.
>
> James Chilton, and his wife, and Mary, their dougter. They had an other doughter, yt was maried, came afterward.
>
> Edward Fuller, and his wife, and Samuell, their sonne.
>
> John Turner, and 2. sones. He had a doughter came some years after to Salem, wher she is now living.
>
> Francis Eaton, and Sarah, his wife, and Samuell, their sone, a yong child.
>
> Moyses Fletcher, John Goodman, Thomas Williams, Digerie Preist, Edmond Margeson, Peter Browne, Richard Britterige, Richard Clarke, Richard Gardenar, Gilbart Winslow.
>
> John Alden was hired for a cooper, at South-Hampton, wher the ship victuled; and being a hopefull yong man, was much desired, but left to his owne liking to go or stay when he came here; but he stayed, and maryed here.
>
> John Allerton and Thomas Enlish were both hired, the later to goe mr [master] of a shalop here, and ye other was reputed as one of ye company, but was to go back (being a seaman) for the help of others behind. But they both dyed here, before the shipe returned.
>
> Ther were allso other 2. seamen hired to stay a year he in the country, William Trevore, and one Ely. But when th time was out, they both returned.
>
> These, bening aboute a hundred sowls, came over in t first ship; and began this worke, which God of his goodn hath hithertoo blesed; let his holy name have ye praise.

Although 102 Pilgrims sailed from England, one die and another was born during the voyage. So 102 reached the harbor at Provincetown, Mass. Four more died and one was born there. The group that landed a Plymouth consisted of 99 Pilgrims.

Later years. The Massachusetts Bay Colony's superior harbor at Boston helped draw trade and settlers from Plymouth Colony. Boundary and trade disputes increased among the colonies that had formed in the are The Pilgrims also faced the danger of attack by nearby Indians and Dutch and French colonists. In 1643, Plymouth Colony joined the Massachusetts Bay, Connecticu and New Haven colonies in forming the New England Confederation. This alliance worked to settle disputes and provide for the common defense.

A long tradition of peace between the Pilgrims and the Wampanoag Indians ended in 1675. That year, Metcomet, the son of Massasoit, led an Indian war against the colonies in New England. The colonists called Metcomet King Philip, and the war became known as King Philip's War (see **Philip, King**). The Indians attacked because they feared that the colonists would take all their land. Metacomet was killed in 1676, and the war in southern New England then ended. Fighting in norther New England continued until 1678. In 1686, King James of England tried to reassert control over the colonies b combining Plymouth and the rest of New England, New York, and New Jersey into the Dominion of New England. However, the dominion proved unpopular and was disbanded in 1689. In 1691, Plymouth became part of Massachusetts Bay Colony.

Joan R. Gundersen

Related articles in *World Book* include:

Alden, John and Priscilla
Bradford, William (Plymouth governor)
Brewster, William
Carver, John
Colonial life in America
Massachusetts (picture: Plimoth Plantation in Plymouth)
Massachusetts Bay Colony
Massasoit
Mayflower
Mayflower Compact
New England Confederation
Pilgrims
Plymouth Company
Plymouth Rock
Puritans
Samoset
Squanto
Standish, Miles
White, Peregrine

Plymouth Company, *PLIHM uhth,* was one of two associations chartered in 1606 by King James I for English merchants and other interested people who wanted to set up trading colonies in America. Its full title was the Virginia Company of Plymouth. The other association was the Virginia Company of London, or the London Company (see **London Company**). The charter gave the Plymouth Company permission to establish a colony in North America between the parallels of 38° and 45° north latitude. The London Company had permission to colonize between 34° and 41° north latitude.

In 1607, explorers for the Plymouth Company founded a colony at the mouth of what is now the Kennebec River on the coast of Maine. The colony failed after one winter. The company then showed only occasional interest in its territory. After 1614, it sponsored explorations

/ Captain John Smith to what is now the New England ·gion. Smith named the area *New England,* mapped its ›ast, and publicized its attractions. See **Smith, John.**

In 1620, a group of investors led by Sir Ferdinando orges, reorganized the company and renamed it the ouncil for New England. Gorges, a leader from the ymouth Company's early expeditions to America, won new royal charter. This charter gave the council con- ol of land between 40° and 48° north latitude and rights ›r fishing off the territory's shores. Settlers from Eng- nd who became known as the Pilgrims established ymouth Colony there in 1620. In 1621, the council ranted the Pilgrims the legal right to settle in its area ee **Plymouth Colony**). The Council for New England /as disbanded in 1637. Pauline Maier

'lymouth Rock, *PLIHM uhth,* a granite boulder with ıe date 1620 carved on it, lies near the sea at Plymouth, ᐱass. According to a popular story, a party of Pilgrim xplorers from the *Mayflower* stepped ashore on this ɔck when they landed at Plymouth on Dec. 21, 1620. ᐱany historians, however, doubt that the Pilgrims actu-



© William Thauer, Cape Scapes

'lymouth Rock stands near the spot where the Pilgrims are be- ieved to have first set foot when they landed at Plymouth Bay in 620. The rock has been moved a number of times. It now tands underneath a granite canopy near the edge of the water.

ılly stepped on the rock. It is more likely that the rock vas near the spot where the Pilgrims landed. The rock vas moved several times between 1774 and 1921. Today, it stands under a granite canopy near the water's ;dge, where it serves as a memorial to the landing of he Pilgrims in 1620. Joan R. Gundersen

Plywood is a building material usually made of an odd ıumber of thin layers of wood glued together. The lay- ɜrs, called *plies* or *veneers,* are arranged so that the *grain direction* (direction of the wood fibers) of each ayer is at right angles to that of the layer next to it. The outside plies are called *faces* and *backs,* and the center ply or plies are called the *core.*

The simplest plywood is made of three plies of ve- neer. However, five, seven, nine, or more plies may be used. In some cases, plywood may have an even num- ber of plies, with the grain direction of the two center plies being parallel. The term *plywood* is also used for door panels that have a solid lumber core up to 3 inches (7.6 centimeters) thick.

Kinds of plywood. Plywood is classified in two ways—by material and by use. Most *softwood* plywood is made of Douglas-fir or southern pine. Western hem- lock, white fir, ponderosa pine, redwood, and many other trees are also used. *Hardwood* plywood is avail- able in over 80 kinds of wood. They include domestic woods such as oak, red gum, poplar, birch, cherry, and walnut. Imported woods used in plywood include ma- hogany and other attractive tropical woods.



American Plywood Assn.

Plywood consists of several *plies* (layers) of wood glued to- gether. It is stronger than ordinary wood and is used chiefly for floors, to line roofs and walls, and for wall paneling.

Interior plywood is usually made with glues that are moisture-resistant. *Exterior* plywood is designed to with- stand severe conditions resulting from moisture and hu- midity. It is always made with waterproof glues.

The most commonly available types of plywood pan- els are 4 feet (1.2 meters) wide, 8 feet (2.4 meters) long, and from $\frac{1}{4}$ to $\frac{3}{4}$ inch (6 to 19 millimeters) thick. Dimen- sions of plywood panels usually range from 3 to 5 feet (0.9 to 1.5 meters) wide, 5 to 12 feet (1.5 to 3.7 meters) long, and $\frac{3}{16}$ to $1\frac{3}{16}$ inches (5 to 30 millimeters) thick. Three, five, or seven plies are normally used.

Use of plywood. Plywood's main advantages over or- dinary lumber are that it is lightweight and workable, yet rigid and strong. Plywood can also be cut to exact sizes and produced in large panels for ease of applica- tion, strength, and smooth surfaces. It shrinks and swells less than ordinary wood and has greater resistance to splitting at the ends. This permits carpenters to fasten plywood sheets with nails or screws close to the edges. Plywood also has little tendency to warp or twist. Deco- rative hardwood veneers can provide the look of expen- sive woods without the cost because only thin sheets are needed. Plastic or metal faces are sometimes used to provide surfaces that resist scratching. Plywood can also be made in curved shapes.

Softwood plywood is used chiefly as a structure upon which finished walls, flooring, and roofing are laid. It is also particularly suited for the forms used in shaping concrete for building, bridge, and dam foundations. Carpenters and cabinetmakers find wide use for hard-

wood plywood in furniture, cabinets, counters, and decorative wall paneling. Manufacturers use both hardwood and softwood in boats, recreational vehicles, office equipment, railroad cars, road signs, sporting goods, and other products.

Making plywood is done in three steps. They involve (1) the log, (2) the veneer, and (3) the lay-up.

Logs used for plywood are selected for straightness, roundness, and freedom from knots and decay. After the bark is removed and the logs cut to the desired lengths, they are often steam-heated. This softens their surfaces, and they are placed into the lathe or slicer to be converted to veneer.

Veneer is made in one of three ways. These are (1) sawing, (2) slicing, or (3) rotary cutting. *Sawing* is used only for fine finishing woods, such as ebony or knotty pine, which are too brittle or unsuitable for slicing. *Slicing* is used chiefly for fine-figured woods for furniture or wall-panel faces. Slicing is done by moving the log, called a *flitch,* against a heavy, stationary knife.

About nine-tenths of veneer is *rotary cut* with a lathe. The log is placed in a lathe and then revolved against a stationary knife extending across its length. The veneer is then unwound in a long, continuous ribbon.

The lay-up takes place after the plies are dried, trimmed, and matched. A thin layer of glue is applied to each ply. Workers then *lay-up,* or place, the plies with the grain in each ply opposite to that in the adjacent ply. Hydraulic presses squeeze the plies together with heat and pressure, or pressure only. Then the finished plywood is again dried, trimmed, sanded, or otherwise finished into sheets. Lewis T. Hendricks

See also **Laminating; Finland** (Manufacturing).

P.M. See **Hour.**

Pneumatic tool, *noo MAT ihk,* is a power implement operated by compressed air. Pneumatic tools have various uses. For example, dentists use air-powered drills to remove tooth decay. Automobile mechanics use pneumatic wrenches to tighten nuts and bolts. Construction workers use pneumatic hammers to break up pavement. In addition, the gas turbines in jet engines and the air brakes in heavy trucks and railroad trains are operated by compressed air.

The air for pneumatic tools is supplied by a machine called an *air compressor.* The compressor squeezes together air molecules, usually to a pressure of about 100 pounds per square inch (690 kilopascals). The air drives the tool in either a *reciprocating* (back and forth) motion or a *rotary* (circular) motion.

Reciprocating motion is used in jackhammers, riveting tools, ramming tools, and digging tools. In these tools, compressed air causes a piston to move back and forth inside a cylinder. The piston then pushes against a striking device at the end of the tool. A small jackhammer can deliver from 2,000 to 3,000 blows per minute. In an air brake, the piston applies or releases the brake after receiving a signal from the driver to do so (see **Brake** [Air brakes]).

Rotary motion is used in power drills, power wrenches, grinders, and sanders. Such tools have a rotating part called a *rotor,* which has several blades. The rotor spins as compressed air is forced against each blade in turn. As the rotor spins, it turns a shaft that is connected to a device for drilling, grinding, or other rotary action. Thousands of rotations may occur per minute. The high speed of the rotations causes the high-pitched noise that comes from a dentist's drill, the turbines in a jet engine, and other rotating pneumatic machinery. Richard M. H. Cheng

Pneumoconiosis. See **Black lung.**

Pneumonia, *noo MOHN yuh,* is a general term for lung diseases involving inflammation. Most cases of pneumonia result from infection, usually by viruses or bacteria, but sometimes by fungi or other microbes. A few cases are caused by allergic reactions or by inhaling irritating chemicals.

Before the development of antibiotic drugs during the 1940's, pneumonia killed about a third of its victims. Today, with appropriate treatment, most pneumonia patients recover. But pneumonia still ranks as one of the leading causes of death in the United States. About 50,000 Americans die of the disease each year.

People with other serious health problems have the greatest risk of getting pneumonia. They also have the most difficulty recovering from it. These individuals include heavy smokers; alcoholics; people with diabetes, cancer, or kidney disease; and people with conditions that weaken the body's resistance to infection. Pneumonia is one of the illnesses most commonly associated with AIDS (acquired immunodeficiency syndrome), a disease that severely weakens the body's immune system. Children and elderly people also have a greater than average risk of developing pneumonia.

How pneumonia develops. In some cases, a person gets pneumonia by inhaling small droplets that contain potentially harmful viruses or bacteria. These droplets are sprayed into the air when an infected person coughs or sneezes. In most other cases, pneumonia results when bacteria normally present in the nose, mouth, or throat invade the lungs. The body's defense mechanisms ordinarily prevent these bacteria from reaching the lungs. But if the body's defense mechanisms are weakened or are already fighting other diseases, pneumonia may develop. Such an infection is called *opportunistic.* Patients hospitalized for other diseases may develop pneumonia from opportunistic microbes or exposure to infectious agents from other patients.

In the lungs, the microbes that cause pneumonia can lodge in the air sacs, where the oxygen is normally exchanged for carbon dioxide in the blood. There, the microbes can multiply rapidly and the air sacs may fill with fluid and with white blood cells produced by the body to fight the infection. When a *lobe* (major section) of a lung is affected, the infection is called *lobar pneumonia.* The infection is called *bronchial pneumonia* if it primarily affects the *bronchioles* (tiny air passages of a lung). *Interstitial pneumonia* chiefly affects the *interstitium,* which are the small spaces between the air sacs and the blood vessels.

Many kinds of viruses can cause pneumonia, including the same ones that cause influenza and other respiratory infections. The most common bacterial causes of pneumonia include *Streptococcus pneumoniae,* also called *pneumococci; Staphylococcus aureus; Haemophilus influenzae;* and *Mycoplasma pneumoniae,* a bacterialike organism that frequently causes pneumonia in children and young adults. Pneumonia associated with Legionnaires' disease is caused by the bacteria

gionella pneumophila or *Legionella micdadei.* A pro-
zoan called *Pneumocystis carinii* frequently causes
eumonia in patients with weakened immune systems,
ch as people with AIDS.

Symptoms and diagnosis. The symptoms of pneu-
onia vary with the type of microbe involved and the
tient's general health before the onset of the disease.
general, the symptoms of bacterial pneumonia are
ore severe than those of viral pneumonia. Most cases
bacterial pneumonia start with a sudden attack of
ills, high fever, and chest pain. The patient also may
velop a painful cough, which is dry at first but later
oduces rust-colored *sputum* (mucus and other sub-
ances from the lungs). Most cases of viral pneumonia
e mild. Symptoms include fever, weakness, cough,
d production of sputum.

Using a stethoscope, a physician can hear characteris-
 sounds from the lungs that indicate the presence of
eumonia. X rays and laboratory tests confirm the diag-
sis. To determine the type of bacteria involved, the
ctor examines the patient's sputum under a micro-
ope. Sputum samples are treated with chemicals and
ains to make the infecting bacteria visible with a mi-
oscope. Other sputum samples are used to *culture*
ow) the infecting organisms in laboratory dishes or
st tubes to help determine its identity. Antibody tests
n identify many viruses that cause pneumonia.

Treatment and prevention. Many people with
eumonia require complete bed rest in a hospital, but
s may not be necessary in mild cases. For viral pneu-
onia, there is no other specific treatment, though
me severe cases may require antiviral drugs. The ma-
rity of cases of viral pneumonia clear up within a few
ys or weeks. Physicians use antibiotics to treat bacte-
l pneumonia. They select the antibiotic thought to be
e most effective in killing the specific kind of bacteria
volved. Some pneumococci and other bacteria have
come resistant to antibiotics, complicating treatment.

Influenza vaccinations protect against pneumonia
used by influenza viruses. Another vaccine protects
e body from pneumonia caused by pneumococci. But
ctors recommend it only for elderly people, patients
th a long-term illness, and other people with a high
k of catching pneumonia. Michael G. Levitzky

See also **AIDS; Anthrax; Legionnaires' disease.**

neumothorax, *NOO moh THAWR aks,* is air or gas in
e space between the lungs and the chest wall. A thin,
ntinuous membrane called the *pleura* covers the out-
de of the lungs and the inside of the chest wall (see
eura). Normally, the part of the pleura covering the
ngs lies close to the part on the inside of the chest.
nly a very thin film of liquid separates the two parts.
dinarily, no air is present in the space between them.
air or gas enters the pleural space, the two sections of
embrane are pushed apart. When a large amount of
 or gas collects between the parts of the pleura on
e side of the chest, the lung on that side cannot fully
pand. Breathing becomes difficult, and the lung may
en collapse.

Pneumothorax may result from a wound in the chest,
ch as a knife wound, or after a sudden tear in the
ng. Infection of the pleural space by gas-producing
crobes can also cause pneumothorax. Physicians treat
eumothorax by removing the gas by suction, surgi-
cally repairing the chest or lung, or prescribing antibiot-
ics when an infection is present. Michael G. Levitzky

Pnom Penh. See Phnom Penh.

Po River is the largest waterway in Italy. It is important for the volume of water it carries from the mountains to the sea and for the fertile valley it has created along its course. The Po begins near Mount Viso, in the Cottian Alps, and flows east about 405 miles (652 kilometers) to a large delta in the Adriatic Sea (see **Italy** [terrain map]). Almost every river in northern Italy is a branch of the Po. Lakes Maggiore, Como, Lecco, Iseo, and Garda also empty their waters into the Po. The river is rapid in its upper courses but becomes a sluggish stream long before it reaches the sea. See also **Italy** (The land).

The Po River has often caused disastrous floods. About 300 B.C. the Etruscans built artificial embankments in an effort to control the waters. The river's continual deposits of silt raise the level of the water. From time to time, the embankments have been raised to heights above the river.

Some of Italy's large cities lie on the banks of the Po, including Turin, Piacenza, and Cremona. Large electric power plants operate along the upper sections of the river. Large ships can sail up the Po as far as Turin, and much freight is carried along this section of the river.

David I. Kertzer

Poaching is the illegal hunting of wild animals. Poaching occurs throughout the world and threatens the survival of many scarce species, such as elephants and rhinoceroses. When animals become extinct, the world loses much of great value. Each species contributes in a unique way to the beauty of nature.

Poachers kill animals for different reasons. Many poachers desire the valuable parts of animals' bodies. Such body parts include the horns of rhinoceroses and the ivory tusks of elephants and walruses. Poachers can sell these body parts for money or trade them for items such as guns and drugs. Other poachers capture live animals, such as small birds, to be sold illegally as pets. Some poachers merely kill animals for fun or to brag about what they poached.

Throughout history, countries have fought poachers



Peter Davey, Bruce Coleman Ltd.

Poaching threatens the survival of many endangered species. This black rhinoceros, one of the rarest animals in the world, was killed by poachers in Kenya for its valuable horn.

in different ways. For hundreds of years in England, poaching the king's deer was a crime punishable by death. Today, the methods used to combat poaching are usually less severe. Biologists study various animals to determine whether they are plentiful enough to be hunted. Species are then classified as *game animals,* which may be legally hunted, and *nongame animals,* which may not be hunted. Laws in many countries dictate when and how many game animals can be killed. Penalties include prison sentences and steep fines.

Many institutions have been established around the world to help reduce poaching. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an international agreement administered by the United Nations to protect wildlife. It prohibits the trade of many nongame animals and their body parts. In the United States, the National Park System and the National Wildlife Refuge System incorporate vast areas of protected land. Many endangered species inhabit these lands. John L. Brooks II

See also **Endangered species; Hunting; National park** (Development of park resources; picture); **Wildlife conservation.**

Pocahontas, *POH kuh HAHN tuhs* (1595?-1617), was the daughter of the American Indian chief Powhatan. She worked to maintain friendly relations between the Indians and early English colonists in America. Captain John Smith, the leader of the settlers in Jamestown, Virginia, claimed that she saved his life. He wrote in his book *The Generall Historie of Virginia, New England, and the Summer Isles* (1624) that Powhatan was about to kill him with a stone war club. But Pocahontas, Smith claimed, placed her head upon his and begged her father to spare him. It is not certain that this is a true story, because Smith, in an earlier book, failed to include an account of this incident.



National Portrait Gallery, Andrew W. Mellon Collection, Washington, D.C.

Pocahontas was the daughter of an American Indian chief. This portrait was painted in England shortly before her death.

The name *Pocahontas* meant *playful one.* She was a child of about 12 at the time of the incident. She is mentioned in William Strachey's *The Histories of Travell into Virginia Britania* (1612). Strachey, the first secretary of the Virginia Colony, said Pocahontas married a chief from her tribe when she was about 14. She was not seen in the Jamestown area for about three years after that.

By 1608, fighting had broken out between the white settlers and Powhatan's Indians. Pocahontas was lured on board an English ship in 1613 and temporarily held captive. During this time, she and the settler John Rolfe fell in love. Pocahontas was converted to Christianity and baptized Rebecca. She married Rolfe in 1614.

Pocahontas went with her husband to London in 1616 to help raise funds for the struggling colonists in Virginia. The English thought of her as an Indian "princess." While waiting to sail back to America, she died of smallpox. Her son, Thomas, was educated in England. He lat went to America and became an important settler in Vi ginia. A number of noted Virginia families claim to be his descendants. James Kirby Martin

See also **Powhatan; Rolfe, John; Smith, John.**

Pocatello, *POH kuh TEHL oh,* Idaho (pop. 51,466), is an air, highway, and rail gateway to the Pacific Northwest is the seat of Bannock County. Greater Pocatello includes Chubbuck and other parts of the county. The cit lies in a rich farming area. It serves as a market and shi ping center for crops and livestock. For location, see **Idaho** (political map).

Factories in Pocatello make elemental phosphorus, fabricated steel products, feed products, flour, frozen food products, malt for brewing, phosphate fertilizers, and semiconductors. The city is the home of Idaho Stat University. Tourists visit Caribou National Forest, the Fort Hall Indian Agency, the Idaho Museum of Natural History, and Ross Park.

Pocatello was founded in 1882. Land did not become available to settlers until 1891, because the area was pa of the Fort Hall Indian Reservation. Pocatello received i city charter in 1893, and was named after a Bannock Indian chief. It grew steadily with the progress of the Union Pacific Railroad, which maintains large yards there. Pocatello has a mayor-council form of government. Don Black

Podgorica, *PAWD guh REET suh* (pop. 117,875), is the capital and largest city of Montenegro, one of the two republics of Yugoslavia. Serbia is the other republic. Podgorica lies in a fertile plain near the junction of the Morava and Zeta rivers. For location, see **Yugoslavia** (map). Podgorica's cultural institutions include a univers ty, a theater, a museum of art, and a sports center. Met works in the city produce aluminum.

Romans built a castle on the site of Podgorica in A.D. 518 and a town grew up around it. Slavic tribes settled in the area in the 600's and called the town Ribnica. The town was renamed Podgorica in 1326. In 1474, it fell to the Ottoman Empire, which ruled Montenegro until th late 1800's. Much of Podgorica was destroyed during World War II (1939-1945). In 1946, the city was renamed Titograd in honor of the Yugoslav leader Josip Broz Tit An earthquake in 1979 caused widespread damage. Th city was renamed Podgorica in 1992. Sabrina P. Ramet

Podiatry, *puh DY uh tree,* is the branch of medicine concerned with the examination, diagnosis, treatment, and prevention of diseases and conditions affecting the human foot, ankle, and related structures. Podiatry is also called *podiatric medicine.* Podiatrists provide med ical and surgical treatment of problems of the foot and its related structures. They may prescribe medication and corrective shoes and also fit corrective devices. Podiatrists treat patients in their offices or in clinics, nursing homes, or hospitals.

There are seven accredited colleges of podiatric med icine in the United States. After an undergraduate education with emphasis in chemistry and biological sciences, a person takes a four-year course leading to the degree of Doctor of Podiatric Medicine (D.P.M.). Most podiatrists complete postgraduate residency training o one or more years. The American Podiatric Medical Association has its headquarters in Bethesda, Maryland.

Critically reviewed by the American Podiatric Medical Association

e, Edgar Allan (1809-1849), was an American poet, ort-story writer, and literary critic. Poe's stormy per- al life and his haunting poems and stories combined make him one of the most famous figures in Ameri- n literary history.

Poe's influence on literature has been immense. His ort story "The Murders in the Rue Morgue" (1841) is nsidered the first modern detective story. His reviews American novelist Nathaniel Hawthorne mark him as first significant theorist of the modern short story. poetry and his stories of terror are among the most luential in modern literature. Writers as diverse as the ottish writer Robert Louis Stevenson and the Russian hor Fyodor Dostoevsky have used Poe's stories to nch their own fictional experiments. Poe celebrated re forms of beauty and opposed the *didactic* (a tend- cy to instruct or moralize) in poetry. These attitudes d a foundation for later literary movements, notably mbolism (see **Symbolism**).

Poe worked as an editor and contributor to maga- es in several cities, including Richmond, Virginia; w York City; and Philadelphia. He unsuccessfully tried found and edit his own magazine, which would have nted him financial security and artistic control in at he considered a hostile literary marketplace.

During his lifetime, Poe made many enemies through challenge to moralistic limits on literature, his con- ntation with the New England literary establishment, d his biting critical style. Some readers too easily ntified Poe with the mentally disturbed narrators of tales, a belief reinforced by Rufus Griswold, Poe's lit- ry executor. Griswold wrote a malicious obituary 49) and memoir (1850) of Poe that combined half- ths and outright falsehoods about Poe's personal bits and conduct. Griswold portrayed Poe as envious, nceited, arrogant, and bad-tempered. Griswold's por- it severely damaged Poe's reputation and delayed a ious consideration of the writer's place in American rature. But Poe's later rediscovery by the French po- Charles Baudelaire, Stéphane Mallarmé, and Paul léry helped restore his reputation.

Poe's life. Poe was born on Jan. 19, 1809, in Boston. s parents were traveling actors. His father deserted family. After his mother died in 1811, Poe became a rd of John Allan, a wealthy Richmond merchant. The an family lived in the United Kingdom from 1815 to 20 before returning to Richmond. In 1826, Poe en- led at the University of Virginia. There he acquired mbling debts that John Allan refused to pay. Eventual- Poe was forced to withdraw from the university.

Poe's relationship with Allan deteriorated, and Poe en- ed in the U.S. Army in 1827. During the same year, e's first book was published. Its title was *Tamerlane d Other Poems,* "By a Bostonian." While waiting for an pointment to the U.S. Military Academy, Poe pub- ed his second volume of poems, *Al Aaraaf, Tamer- e, and Minor Poems* (1829). Both collections show the luence of the English poet Lord Byron. In 1830, Poe tered the U.S. Military Academy at West Point, New rk, where he excelled in the study of languages. But was expelled in 1831 for neglecting his duties.

Poe's *Poems* (1831) contained two important poems, Helen" and "Israfel." He began to write tales in the rly 1830's while living with his aunt Maria Clemm and her daughter Virginia. Poe suffered financial difficulties, especially after being ignored in John Allan's will. With help from the American novelist John P. Kennedy, Poe won an editorial post with the *Southern Literary Messenger* in Richmond. In 1836, Poe married Virginia, his 13-year-old cousin. For the *Messenger,* Poe contributed reviews, original or revised poems and stories, and two installments of *The Narrative of Arthur Gordon Pym.*

Poe produced several of his finest tales in the late 1830's, including "Ligeia," "The Fall of the House of Usher," and "William Wilson." These and other stories were incorporated into *Tales of the Grotesque and Arabesque* (1839). In 1841, he became an editor of *Graham's Magazine,* to which he contributed "The Murders in the Rue Morgue."

Poe won greater recognition with "The Gold Bug" (1843), a prize-winning tale that appeared in Philadelphia's *Dollar Newspaper.* The poem "The Raven" (1845) made him famous. Two more collections, *Tales* and *The Raven and Other Poems,* appeared in 1845. Early in 1845, Poe antagonized many people with a scathing campaign against the popular American poet Henry Wadsworth Longfellow for supposed plagiarisms. At a public appearance in Boston later that year, Poe admitted to being drunk, which further alienated the public.

Poe's later years were colored by economic hardship and ill health. But he produced the story "The Cask of Amontillado" (1846), "The Philosophy of Composition" (1846), and part of his "Marginalia," a collection of critical notes written for various periodicals during the 1840's.

Virginia Poe died of tuberculosis in 1847, after five years of illness. Poe then sank into poor health, and his literary productivity declined. In the middle and late 1840's, he sought to support himself as a lecturer. His lecture on "The Universe" was expanded into *Eureka: A Prose Poem* (1848), which explores the mysteries of the universe.

In 1849, Poe became engaged to marry the widowed Sarah Elmira Royster Shelton, his boyhood sweetheart. On his way to bring Maria Clemm to the wedding, Poe stopped in Baltimore. On October 3, he was found semiconscious and delirious outside a tavern used as a polling place. The cause of his death four days later was listed as "congestion of the brain," though the circumstances of his death have never been fully explained.

Poetry and poetic theory. Poe began his career as a poet, and composed or revised poems throughout his career. A tone of amused distance can be detected even in poems that critics consider serious. However, these elements coexist with themes that are more typical of the Romantic movement, such as dreams and nightmares (see **Romanticism**). Poe handled such material through images and *tropes* (figures of speech) designed to signify uncertain states of consciousness represented as lakes, seas, waves, and vapors.

Nearly all Poe's criticism on poetry was written for the magazines for which he worked. The pieces reflect a coherent, self-conscious view of poetry and of the creative process. Poe wrote "The Philosophy of Composition" to explain how he composed "The Raven." The essay opposes the Romantic assumption that the poet works in a "fine frenzy" of pure inspiration. Instead, Poe wrote a careful account of poetic creation. The essay analyzes the central role of "effect," the conscious choice of an

emotional atmosphere that is more important than incident, character, and versification. Poe also offered his famous pronouncement that the death of a beautiful woman is the most poetical topic in the world. In "The Poetic Principle" (1850), Poe claimed that poetry works to achieve "an elevating excitement of the soul," an emotional state that could not be long sustained. He further declared that a "long poem" is a contradiction in terms.

Poe believed that a poem's emotional impact was enhanced by music or "sweet sound." He thus devoted considerable attention to techniques of versification, especially in his essay "The Rationale of Verse" (1848).

Poe's "Sonnet—To Science" (1829) subtly shows how beauty is destroyed by the coldness of the modern scientific intellect. "To Helen" (1831) is a brilliant example of precision and balance and perhaps Poe's classic poetic statement on the idealization of women.

Despite its theatrical effects and stylistic flaws, "The Raven" (1845) is Poe's best-known poem and one of the most famous works in American literature. It treats his favorite theme, the death of a beautiful woman. This theme also appears in "The Sleeper" (1841) and "Ulalume" (1847). In all three poems, Poe chose elaborate musical and metrical effects, which have been widely criticized and parodied. Poe sought an *incantatory* quality in his verse—that is, a hypnotic quality of rhythm.

Reflecting his interest in musical effects, Poe made no rigid distinction between music and poetry. "Eldorado" (1849), which originated as a song of the American West about the California gold rush, is an outstanding example. Poe went beyond the poem's topical nature. The theme is universalized, as a knight learns that the true Eldorado is a wealth beyond this world.

Fiction and theory of fiction. Poe's review of the American novelist Robert Montgomery Bird's supernatural novel *Sheppard Lee* (1836) offers penetrating comments on fantasy literature. Poe distinguished genius from talent in his review of the English novelist Charles Dickens's *The Old Curiosity Shop* (1841). Critiques of the American writer Nathaniel Hawthorne's tales offer Poe's most sustained views on prose fiction. Poe approached the tale as a painter or a landscape architect might deal with his or her craft. He discussed the importance of "design," the reconciliation of diverse elements into a "unity of effect or impression." Poe's review of *Twice-Told Tales* (1842) celebrates the short prose tale as much as Hawthorne's artistry. "Tale-Writing—Nathaniel Hawthorne" (1847), in contrast, criticizes Hawthorne's lack of originality and his strong liking for *allegory*—that is, a story with both a literal and a symbolic meaning (see **Allegory**). According to Poe, the "proper uses" of prose fiction are served only when allegory is suggestive—that is, when it ceases to "enforce a truth" and offers an unobtrusive "under-current" of meaning.

Much of Poe's early fiction was written for *Tales of the Folio Club,* a series of satires on the literary pretensions of his day that was never published as a separate volume. In these pieces, serious and satirical elements coexist. These stories, the most notable of which are "Metzengerstein" and "The Assignation," do not conform to his principle of "unity of effect." Rather, the tone is a combination of "half banter, half satire." Poe's only long work of fiction, the sea story *The Narrative of Arthur Gordon Pym* (1838), may have been begun in this style. But modern critics have uncovered suggestions of mythical, religious, and visionary meaning in its ending.

Poe's most famous fictional expression of the unity of effect is "The Fall of the House of Usher" (1839). The story is a portrait of a suffering artist isolated from the tides of life. Subtle psychological meanings can also be found in "Ligeia," "The Cask of Amontillado," and "William Wilson." In all three tales, bizarre and frightening details and events conceal Poe's subtle probing of the warfare he observed in the human soul. Kent Ljungquist

See also **American literature** (picture).

Additional resources

Frank, Frederick S., and Magistrale, Anthony. *The Poe Encyclopedia.* Greenwood, 1997.
Silverman, Kenneth. *Edgar Allan Poe.* 1991. Reprint. HarperPerennial, 1992.

Poem. See Poetry.

Poet laureate, *LAWR ee iht,* is the official poet of a state or nation. Since 1668, the king or queen of the country now known as the United Kingdom has appointed an official poet laureate. To honor special occasions, the poet laureate usually writes a formal poem called an *ode.* The poet laureate is appointed for life.

Many states in the United States have poet laureates. In 1985, Congress authorized naming a poet laureate for the nation. The Librarian of Congress makes the appointment, in consultation with former appointees, the current laureate, and poetry critics. The annual appointment runs from October to May.

Poets laureate of the United Kingdom

Name	Born	Appointed	Died
* John Dryden	1631	1668	1700
Thomas Shadwell	1642?	1689	1692
Nahum Tate	1652	1692	1715
Nicholas Rowe	1674	1715	1718
Laurence Eusden	1688	1718	1730
Colley Cibber	1671	1730	1757
William Whitehead	1715	1757	1785
Thomas Warton	1728	1785	1790
Henry James Pye	1745	1790	1813
* Robert Southey	1774	1813	1843
* William Wordsworth	1770	1843	1850
* Alfred, Lord Tennyson	1809	1850	1892
Alfred Austin	1835	1896	1913
Robert Bridges	1844	1913	1930
* John Masefield	1878	1930	1967
* Cecil Day-Lewis	1904	1968	1972
* John Betjeman	1906	1972	1984
* Ted Hughes	1930	1984	1998
* Andrew Motion	1952	1999	

*Has a separate biography in *World Book.*

Poets laureate of the United States

Name	Born	Appointed	Died
* Robert Penn Warren	1905	1986	1989
* Richard Wilbur	1921	1987	
Howard Nemerov	1920	1988	1991
Mark Strand	1934	1990	
* Joseph Brodsky	1940	1991	1996
Mona Van Duyn	1921	1992	
* Rita Dove	1952	1993	
Robert Hass	1941	1995	
Robert Pinsky	1940	1997	
Stanley Kunitz	1905	2000	
Billy Collins	1941	2001	

*Has a separate biography in *World Book.*

ᵓoetry

ᵓoetry is a type of literature in which the sound and ıeaning of language are combined to create ideas and :elings. The first part of "Break, Break, Break," a poem 'y the English poet Lord Tennyson that was first pubshed in 1842, helps show how poetry does this:

> Break, break, break,
> On thy cold gray stones, O Sea!
> And I would that my tongue could utter
> The thoughts that arise in me.

ı these four lines, Tennyson reflects on the connection etween the sea and himself. The sea breaks up on ocks much as the poet's thoughts seem to break up on is tongue before he can explain how he feels. This conection between the sea and the poet is reinforced by ıe fact that "Sea" rhymes with "me." In addition, the two nes about the sea and the two lines about the poet ave the same three-beat rhythm. Tennyson could have irectly stated how he felt by writing something like: "I /ish I could tell you how rotten I feel today." By using oetry, however, Tennyson helped his readers both unerstand and feel how he felt.

Many people are first attracted to poetry by the ound and rhythm of a poem's words. For example, chilren delight in the pleasing rhymes and strong rhythms f nursery rhymes. Youngsters often clap their hands to uch verses for the simple enjoyment of matching the hythm of their bodies with the rhythm of the language.

Poetry began in prehistoric times. Early peoples used oetic language with accompanying music in songs, rayers, and magic spells. The patterns of rhyme and hythm helped people remember and so preserve oral oetry from generation to generation. After the developıent of writing, poetry gradually became an important /ritten art. Today, millions of people throughout the /orld continue to listen to or read poetry. Many people lso write poetry.

Kinds of poetry

Through the years, poets have developed many kinds f poetry. The three main kinds are (1) lyric, (2) narrative, nd (3) dramatic.

Lyric poetry is by far the most common type of potry. The word *lyric* comes from *lyre,* a harplike instruıent played by ancient Greek poets during recitals of ıeir shorter poems. Today, lyric poetry means any short oem.

The *haiku,* a Japanese form, is one of the shortest /pes of lyric poetry. In Japanese, the haiku consists of 7 syllables arranged in three lines. The first line has 5 yllables, the second 7, and the third 5. Some English anslations of haiku try to capture their effect rather ıan imitate their form. For example, the following transıtion by the Australian poet Harold Stewart of a haiku y the Japanese poet Issa has two lines of 10 syllables ach:

> In these degenerate latter days, I stare
> Astounded: cherry-blossoms everywhere!

Other lyric forms are longer and more complicated than the haiku. The *ode* is a serious, elaborate lyric full of high praise and noble feeling. Many odes mark important public events. The *classical ode,* also called the *Pindaric ode* or *choral ode,* was developed by the ancient Greeks. It consists of three parts. The first two parts, the *strophe* and *antistrophe,* have the same pattern of rhyme. The third part, the *epode,* has a different pattern. Most odes that were developed later consist of stanzas with the same pattern of rhythm and rhyme.

The *elegy,* another common lyric, is a meditation on life and death. Many elegies mourn the death of a famous person or a close friend. The *sonnet* is a 14-line lyric with a certain pattern of rhyme and rhythm. Many sonnets are love poems. Other lyric forms include the *limerick, rondel, triolet,* and *villanelle.* For descriptions of these forms, see the table *Terms used in poetry.*

Narrative poetry tells stories. There are two chief kinds of narrative poems: (1) epics and (2) ballads.

Epics are long poems. Most epics describe the deeds of heroes in battle or conflicts between human beings and natural and divine forces. Many other epics tell of the origin or history of a people. Epics are probably the oldest surviving form of poetry. Many scholars believe that the *Iliad* and the *Odyssey,* two of the most famous epics in Western literature, were composed during the 700's B.C. These works are traditionally attributed to the Greek poet Homer. The *Iliad* describes events in the last year of the Trojan War, which was fought between Greece and the city of Troy. The *Odyssey* tells of the adventures of Odysseus, king of Ithaca, on his return home after having fought for Greece in the Trojan War.

Ballads tell shorter stories about a particular person. For example, many ballads in English literature describe the adventures of Robin Hood, a legendary outlaw who stole from rich people and gave to the poor. Some ballads date from the 1300's.

Dramatic poetry, like narrative poetry, tells stories. But in dramatic poetry, the poet lets one or more of the story's characters act out the story. Many plays are written as dramatic poetry. The difference between drama and dramatic poetry is a matter of degree. If the dialogue of a play rhymes, has repeating rhythms, or features other distinct poetic elements, the play is considered to be dramatic poetry. The English playwright William Shakespeare is the most famous dramatic poet.

In the *dramatic monologue,* the story is told in the words of only one character. Robert Browning, an English poet of the 1800's, wrote many poems in this style.

The elements of poetry

Rhythm and meter. The word *rhythm* comes from the Greek word *rhein,* which means *to flow.* Rhythm fills the world with repetition and flow, from the beat of our hearts to the rise and fall of ocean tides.

Rhythm in poetry means the flow of sound produced by language. In many poems, we can sense something repeating in the rhythm. This pattern of rhythm in a poem is called *meter.* Meter gives form to what we hear in a poem by telling us what to expect the flow of lan-

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guage to do from line to line. However, the actual rhythm of any line may not follow the meter exactly. In certain poems, the rhythm varies so much from the meter that the sense of meter is almost lost. The poet's decision to follow the meter closely or to vary from it greatly depends on the particular effects the poet wants to create. The poet may also decide to use no meter at all. Much modern poetry has no meter.

Meter varies according to the sounds of the language in which a poem is written. For example, Cheyenne, an American Indian language, has whispered syllables as well as spoken ones. The meters of Cheyenne poetry reflect this characteristic. The ancient Greeks based their meters on the long and short vowels in their words.

In poetry written in English, meters are based on syllables and on *stress* (the vocal emphasis given to a syllable). Poets who work in English use three chief types of meters: (1) syllabic, (2) stress, and (3) foot-verse.

Syllabic meters are based on the number of syllables in a line. The most common syllabic meters are *continuous syllabics* and *stanzaic syllabics.*

In continuous syllabics, the poet uses the same number of syllables in each line of the poem. In stanzaic syllabics, the number of syllables in each line of the first stanza is repeated in the corresponding lines of all othe[r] stanzas.

Stress meters are based on the number of stressed syllables in a line. The stress meters most used in the tradition of poetry in English are the Folk Meters. One widely used Folk Meter is *Long Measure,* which has a pattern of four beats per line. The American poet E. E. Cummings used Long Measure in "anyone lived in a pretty how town" (1940). In the following stanza from that poem, the Long Measure pattern of four beats per line quickly establishes itself. The underlined syllables and words indicate where beats might occur:

> stars rain sun moon
> (and only the snow can begin to explain
> how children are apt to forget to remember
> with up so floating many bells down)

Great poets

Masters of poetry from the 1200's to the present are listed in chronological order. Great poets who lived before the 1200's include Homer of Greece, Virgil of Rome, and Li Po of China. Outstanding poems written before the 1200's by unknown authors include *Beowulf* (700's) and *The Song of Roland* (about 1100).

Each poet has a separate biography in *World Book.*

Dante Alighieri

William Shakespeare

T. S. Eliot

John Milton (1608-1674) Engla[nd]
John Donne (1572-1631) England
William Shakespeare (1564-1616) England
Edmund Spenser (1552?-1599) England
Pierre de Ronsard (1524-1585) France
Joachim Du Bellay (1522-1560) France
François Villon (1431- ?) France
Geoffrey Chaucer (1340?-1400) England
William Langland (1332?-1400?) England
Petrarch (1304-1374) Italy
Dante Alighieri (1265-1321) Italy

1300 1400 1500 1600

Another Folk Meter, *Common Measure,* alternates our-beat and three-beat lines. It is used in ballads, ymns, lyric poems, and nursery rhymes. "I Heard a Fly uzz," by Emily Dickinson, is in Common Measure:

> I heard a Fly buzz—when I died—
> The Stillness in the Room
> Was like the Stillness in the Air—
> Between the Heaves of Storm—
>
> The Eyes around—had wrung them dry—
> And Breaths were gathering firm
> For that last Onset—when the King
> Be witnessed—in the Room—
>
> I willed my Keepsakes—Signed away
> What portion of me be
> Assignable—and then it was
> There interposed a Fly—
> With Blue—uncertain stumbling Buzz—
> Between the light—and me—
> And then the Windows failed—and then
> I could not see to see—

When we read this poem, we pause at the end of each three-beat line. We pause because we tend to hear beats in pairs. The first line of the poem has two pairs of beats, and so we expect the following lines to repeat this pattern. Thus, we pause after the three-beat lines for the expected final beat in the second pair of beats. Such pauses are regarded as *musical pauses* because they are created by the meter of the poem. They differ from *caesuras,* which are pauses created by commas, periods, and other punctuation marks. A musical pause also differs from the felt pause that we should sense at the end of any line of poetry. When reading a poem aloud, people too often ignore the end of lines and read the poem as if it were prose. The trick in reading a poem aloud is to signal the ends of lines in some way without coming to a full stop. "I Heard a Fly Buzz" has many kinds of pauses, each adding to the poem's effect.

Foot-verse meters involve both the number of syllables and the position of the stressed syllables. These combinations form *feet.* Poets have created many types of foot-verse meters. The most widely used type by far

Gerard Manley Hopkins (1844-1889) England
Stéphane Mallarmé (1842-1898) France
Emily Dickinson (1830-1886) United States
Charles Baudelaire (1821-1867) France
Walt Whitman (1819-1892) United States
Robert Browning (1812-1889) England
Lord Tennyson (1809-1892) England
Edgar Allan Poe (1809-1849) United States
Henry Wadsworth Longfellow (1807-1882) United States
Victor Hugo (1802-1885) France
Alexander Pushkin (1799-1837) Russia
Heinrich Heine (1797-1856) Germany
John Keats (1795-1821) England
Percy Bysshe Shelley (1792-1822) England
Lord Byron (1788-1824) England
Samuel Taylor Coleridge (1772-1834) England
William Wordsworth (1770-1850) England
Johann Schiller (1759-1805) Germany
Robert Burns (1759-1796) Scotland
Johann von Goethe (1749-1832) Germany
Thomas Gray (1716-1771) England
exander Pope (1688-1744) England
n Dryden (1631-1700) England

Seamus Heaney (1934-) Ireland
Wole Soyinka (1934-) Nigeria
Derek Walcott (1930-) Saint Lucia
Rita Dove (1952-) United States
Nikki Giovanni (1943-) United States
Adrienne Rich (1929-) United States
Yevgeny Yevtushenko (1933-) Soviet Union
Sylvia Plath (1932-1963) United States
W. S. Merwin (1927-) United States
Robert Creeley (1926-) United States
Robert Duncan (1919-1988) United States
Gwendolyn Brooks (1917-2000) United States
Robert Lowell (1917-1977) United States
Octavio Paz (1914-1998) Mexico
Dylan Thomas (1914-1953) Wales
W. H. Auden (1907-1973) England
Pablo Neruda (1904-1973) Chile
Vicente Aleixandre (1898-1984) Spain
Federico Garcia Lorca (1898-1936) Spain
Claude McKay (1890-1948) Jamaica
T. S. Eliot (1888-1965) England
Marianne Moore (1887-1972) United States
Ezra Pound (1885-1972) United States
William Carlos Williams (1883-1963) United States
Wallace Stevens (1879-1955) United States
Carl Sandburg (1878-1967) United States
Rainer Maria Rilke (1875-1926) Germany
Robert Frost (1874-1963) United States
Hugo von Hofmannsthal (1874-1929) Germany
Paul Valéry (1871-1945) France
Rubén Darío (1867-1916) Nicaragua
William Butler Yeats (1865-1939) Ireland
Arthur Rimbaud (1854-1891) France
Paul Verlaine (1844-1896) France

1700 1800 1900 2000

is *iambic pentameter,* a line consisting of five *iambs.* An iamb is a two-syllable foot in which the second syllable receives more stress than the first syllable. For example, the words *indeed, between,* and *mistake* form iambs.

In many cases, the pattern of stresses in iambic pentameter is harder to hear than in stress meters. In a line of stress meter, we easily recognize the pattern of heavy stresses. In a line of iambic pentameter, however, we must consider all the syllables and compare the stresses of the two syllables that make up each foot to identify the pattern.

If a poem is said to be written in iambic pentameter, the reader can expect each line of the poem to consist of five iambs. In some poems, the rhythm of the lines fulfills that expectation, as it does in these final two lines from "Composed Upon Westminster Bridge, September 3, 1802" by the English poet William Wordsworth:

> Dĕar Gód! | thĕ vé | ry̆ hóus | ĕs séem | ăsléep;
> Ănd áll | thăt míght | y̆ héart | ĭs lý | ĭng stíll!

The syllable that has less stress in each foot is marked with a breve (˘). The syllable with greater stress is marked with an accent (ˊ). The feet are separated by vertical lines called *foot boundaries.* Marking poetry in this way to find its metrical pattern is called *scanning.*

Most poets do not try to fit the rhythm to the meter exactly. Instead, they strive for the most appropriate kind of fit for the effect they wish to create. For example, the Jamaican-born poet Claude McKay wrote "If We Must Die" (1922) in iambic pentameter. But the rhythm of the last two lines of the poem only roughly fits that meter:

> Lĭke mén | wĕ'll fáce | thĕ múr | dĕrŏus, ców | ărdly̆ páck,
> Préssed tŏ | thĕ wáll, | dýĭng, | bŭt fíght | ĭng báck!

Excerpt from "If We Must Die" by Claude McKay from *The Selected Poems of Claude McKay.* Copyright 1981 by Twayne Publishers, Incorporated. Used by permission of The Archives of Claude McKay, Carl Cowl, Administrator.

In the fourth and fifth feet of the first line, McKay used a three-syllable foot instead of an iamb. In the second line, he substituted a *trochee* for an iamb in the first and third feet. A trochee is a two-syllable foot with the stress heavier on the first syllable. The rhythm of these two lines fights against the poem's meter, much as the men in the poem fight the pack, and so helps add to the poem's sense of struggle.

Sounds. Poets often use the sounds of words to create effects in their poems. The most common method is to use words that rhyme. If the words at the ends of two

Terms used in poetry

Alexandrine, *AL ihg ZAN drihn,* is a line of verse having 12 syllables. It is the most common meter in French poetry.

Alliteration, *uh LIHT uh RAY shuhn,* occurs when two or more words begin with the same sound.

Anacrusis, *AN uh KROO sihs,* is one or more unstressed syllables at the beginning of a line that do not form part of the regular meter.

Anapest, *AN uh pehst,* refers to a three-syllable foot in which the greatest stress falls on the final syllable.

Assonance, *AS uh nuhns,* is the repetition of vowel sounds with varying consonant sounds. The words *mine* and *night,* for example, have assonance of *i* sounds.

Blank verse means poetry in unrhymed iambic pentameter.

Caesura, *sih ZHUR uh,* is a pause indicated by a comma, period, or other punctuation mark.

Catalexis, *KAT uh LEHK suhs,* or **truncation**, *truhng KAY shuhn,* is the omission of an expected unstressed syllable from the end of a line.

Consonance, *KAHN suh nuhns,* occurs when the same consonant sound is repeated.

Couplet is a pair of rhyming lines. *Closed couplets* complete a sentence in two lines. *Open couplets* continue the sentence from one pair of lines to another. *Heroic couplets* are in iambic pentameter.

Dactyl, *DAK tuhl,* is a three-syllable foot in which the first syllable receives the strongest stress.

Dimeter, *DIHM uh tuhr,* is a line of two feet.

Double rhyme has two rhyming syllables, as in *dreary* and *weary* or *market* and *park it.*

Elision, *ih LIHZH uhn,* is the dropping of a syllable, or the combining of two syllables into one.

Foot is a metrical unit of two or more syllables.

Free verse means poetry without meter and without a rhyme scheme.

Heptameter, *hehp TAM uh tuhr,* is a line of seven feet.

Hexameter, *hehk SAM uh tuhr,* is a line of six feet.

Iamb, *EYE amb,* is a two-syllable foot in which the second syllable has more stress than the first.

Iambic pentameter, *eye AM bihk pehn TAM uh tuhr,* consists of a line of five iambs.

Limerick is a five-line form of humorous verse. It is written in *Poulter's Measure,* which consists of 13 beats and has a rhyme scheme of *aabba.*

Meter means the pattern of rhythm in a poem.

Monometer, *muh NAHM uh tuhr,* is a line that consists of one foot.

Octameter, *ahk TAM uh tuhr,* is a line of eight feet.

Octave is an eight-line stanza. It commonly refers to the first eight lines of an Italian sonnet.

Onomatopoeia, *AHN uh MAT uh PEE uh,* is a word whose sound suggests the sound it refers to. For example, the word *buzz* suggests as well as refers to the sound made by bees.

Pentameter, *pehn TAM uh tuhr,* is a line of five feet.

Quatrain is a four-line stanza or four-line poem.

Rhyme scheme means the pattern of rhymes in a stanza or poem.

Rondel is a 13- or 14-line poem in which the first line, A, and the second line, B, are repeated near the middle and at the end. The 14-line form rhymes *ABba abAB abbaAB.*

Sestet is the last six lines of an Italian sonnet. It also refers to any six-line stanza or six-line poem.

Sonnet is a 14-line form with several possible rhyme schemes. The *Italian* sonnet, also called *Petrarchan sonnet,* usually rhymes *abbaabba cdecde* or *abbaabba cdcdcd.* The English sonnet, or *Shakespearean sonnet,* rhymes *abab cdcd efef gg.*

Sonnet sequence is a series of sonnets with a similar subject.

Stanza is a repeated pattern of lines, usually with a meter and rhyme scheme.

Tercet, or triplet, is a three-line stanza or a three-line poem.

Tetrameter, *teh TRAM uh tuhr,* is a line of four feet.

Trimeter, *TRIHM uh tuhr,* is a line of three feet.

Triolet is a complex eight-line French form, in which the first line, A, is repeated twice and the second line, B, once. Its rhyme scheme is *ABaAabAB.*

Trochee, *TROH kee,* is a two-syllable foot in which the first syllable is more stressed than the second.

Villanelle, *VIHL uh NEHL,* is an elaborate 19-line French form. It repeats two rhyming lines, *A* and *A′*, in an intricate pattern: *AbA′ abA abA′ abA abA′ abAA′.*

or more lines of a poem rhyme, the poem has a *rhyme scheme*. The English poet Gerard Manley Hopkins used a rhyme scheme in "Pied Beauty." This poem, written in 1877, celebrates *pied,* or *dappled,* things—that is, spotted, many-colored things:

> Glory be to God for dappled things—
> For skies of couple-colour as a brinded cow;
> For rose-moles all in stipple upon trout that swim;
> Fresh-firecoal chestnut-falls; finches' wings;
> Landscape plotted and pieced—fold, fallow, and plough;
> And all trades, their gear and tackle and trim.
>
> All things counter, original, spare, strange;
> Whatever is fickle, freckled (who knows how?)
> With swift, slow; sweet, sour; adazzle, dim;
> He fathers-forth whose beauty is past change:
> Praise him.

In the standard way of indicating a rhyme scheme, the letter *a* represents the first rhyme sound, *b* the second, *c* the third, and so on. Thus, the rhyme scheme of "Pied Beauty" is *abcabc dbcdc.*

Poets also achieve effects by using words that have similar sounds but do not rhyme. Many such words appear in "Pied Beauty." For example, the first two lines of the poem have words that begin with the same *g* sound ("*G*lory be to *G*od") and the same *c* sound ("*c*ouple*c*olour as a brinded *c*ow"). Such repetition of the same first sounds in words is called *alliteration. Consonance* occurs when the same consonant sound is repeated. The third line of "Pied Beauty" has consonance of *l* sounds ("rose-mo*l*es a*ll* in stipp*l*e") and t sounds ("*t*rou*t* tha*t* swim"). The repetition of a vowel sound is called assonance. In the fourth line of the poem, the *e* sounds and the last two *i* sounds are examples of *assonance* ("Fr*e*sh-firecoal ch*e*stnut-falls; f*i*nches' w*i*ngs"). The fifth line of "Pied Beauty" combines alliteration, consonance, and assonance. Hopkins thus created a poem that in itself is a "dappled thing" of sound.

Imagery refers to the sensations that language creates in the mind. These sensations, or images, are often thought of as being like pictures. But images are not limited to visual sensations. For example, the first three stanzas of "The Snow Man" (1923) by the American poet Wallace Stevens appeal to our sense of touch and our sense of hearing:

> One must have a mind of winter
> To regard the frost and the boughs
> Of the pinetrees crusted with snow;
>
> And have been cold a long time
> To behold the junipers shagged with ice,
> The spruces rough in the distant glitter
>
> Of the January sun; and not to think
> Of any misery in the sound of the wind,
> In the sound of a few leaves....

In these lines, such phrases as "crusted with snow," "shagged with ice," and "rough in the distant glitter" help us sense the texture of things. In the third stanza, "the sound of the wind" and "the sound of a few leaves" create images of things heard.

Poets also create images by comparing things that ordinarily have little in common. In "Little Exercise" (1946), the American poet Elizabeth Bishop compared an approaching storm to a restless dog. This comparison suggests images of both sound and movement:

> Think of the storm roaming the sky uneasily
> like a dog looking for a place to sleep in,
> listen to it growling.

Forms. Poets give form to their verse in various ways. The most common means of creating poetic form is rhyme. Some rhyme schemes have been used so often that they have become standard verse forms. One such form is the sonnet. The *Italian sonnet,* also called the *Petrarchan sonnet,* consists of an *octave* (eight-line stanza) followed by a *sestet* (six-line stanza). The rhyme scheme of the octave is *abbaabba.* The rhyme scheme of the sestet varies but often is *cdecde* or *cdcdcd.* The *English sonnet,* also called the *Shakespearean sonnet,* has a rhyme scheme of *abab cdcd efef gg.* Shakespeare used this form in his sonnets. His Sonnet 130, which was published in 1609, follows:

> My mistress' eyes are nothing like the sun—
> Coral is far more red than her lips' red—
> If snow be white, why then her breasts are dun—
> If hairs be wires, black wires grow on her head:
> I have seen roses damasked, red and white,
> But no such roses see I in her cheeks,
> And in some perfumes is there more delight
> Than in the breath that from my mistress reeks.
> I love to hear her speak, yet well I know
> That music hath a far more pleasing sound.
> I grant I never saw a goddess go;
> My mistress when she walks treads on the ground.
> And yet by heaven I think my love as rare
> As any she belied with false compare.

A poem's meter also may determine its form. For example, *blank verse* consists of unrhymed lines of iambic pentameter. The English poet John Milton wrote the great epic *Paradise Lost* (1667) in blank verse.

Much poetry, especially that written in the 1900's, has no rhyme scheme and no meter. Such poetry is often called *free verse.* The American poet Theodore Roethke used no rhyme scheme and no meter in "Root Cellar" (1943). The unpredictable form of Roethke's poem echoes the unexpected behavior of the things in the cellar:

> Nothing would sleep in that cellar, dank as a ditch,
> Bulbs broke out of boxes hunting for chinks in the dark,
> Shoots dangled and drooped,
> Lolling obscenely from mildewed crates,
> Hung down long yellow evil necks, like tropical snakes.
> And what a congress of stinks!
> Roots ripe as old bait,
> Pulpy stems, rank, silo-rich,
> Leaf-mold, manure, lime, piled against slippery planks.
> Nothing would give up life:
> Even the dirt kept breathing a small breath.

History

Ancient poetry. Poets have been an important part of many cultures since early times. In ancient Greece,

poets recited their works at religious festivals and other important public ceremonies. The major forms of ancient Greek poetry were the epic, the lyric, and the dramatic poem.

The oldest surviving Greek poems are the great epics the *Iliad* and the *Odyssey*. These works, which are attributed to Homer, were probably written during the 700's B.C. They were composed from pieces of Greek oral poetry, such as folk tales and songs. After Homer's time, poets recited the two works from memory before large audiences at Greek festivals.

Lyric poetry in ancient Greece was recited by one person or by a large group called a *chorus*. Sappho, a Greek woman poet of the 500's B.C., composed many elegant love lyrics. Many later poets have written poems consisting of four-line stanzas called *Sapphics*, which imitate the style of Sappho. Pindar, who lived during the 400's B.C., was the greatest Greek choral lyric poet. Most scholars credit him with developing the classical ode.

Greek dramatic poets included some of the finest playwrights in history. Aeschylus, Euripides, and Sophocles, all of whom lived in the 400's B.C., composed masterpieces of tragedy. Aristophanes, another Greek poet of the 400's B.C., wrote brilliant comedies.

Greek poetry strongly influenced the poets of ancient Rome. For example, the *Iliad* and the *Odyssey* served as models for the *Aeneid*, an epic composed by the Roman poet Virgil between 30 and 19 B.C. This masterpiece tells the story of Aeneas, a mythical Trojan warrior. Other outstanding poets of ancient Rome included Ovid, Catullus, and Juvenal. Ovid and Catullus composed graceful love poems. Juvenal became famous for stinging *satires*—works that ridicule certain aspects of human behavior.

The Old Testament contains beautiful poetry of the ancient Hebrews. Much of the Old Testament began as oral literature and was written down over hundreds of years. The Psalms and the Song of Solomon provide examples of some of the loveliest and most powerful Hebrew lyrics. Hebrew poets created rhythm in their verse by repeating words, ideas, and images. Other ancient cultures in which poetry flourished included those of China and India.

Medieval poetry consists of poems written during the Middle Ages, a period in European history from about the A.D. 400's to the 1500's. Most early medieval poems were epics about heroic figures, such as kings and chieftains in battle. Many of these poems were not written down and have disappeared. Two surviving epics are *Beowulf*, believed to have been composed during the 700's by one or more unknown poets; and *The Song of Roland*, written about 1100 by an unknown French poet.

Beginning about 900, lyric poetry flourished in western Europe. In France, many nobles composed and sang lyrics about courtly love. These poet-musicians were called *troubadours* in southern France and *trouvères* in northern France. A similar group, called *minnesingers*, performed in Germany beginning in the 1100's.

Much medieval poetry reflects the central role of the Christian church in European life. Christianity united a majority of Europeans under one faith, thus creating a common cultural setting in which poets shared themes. The powerful influence of the church is evident in *The Divine Comedy*, an epic written in the early 1300's by th Italian poet Dante Alighieri. Dante himself is the main character in this masterpiece, which tells of his dream-like journey through hell and purgatory to heaven.

During the 1300's, the *romance* became the chief form of poetry in England and France. Many romances told of knightly deeds and chivalry. *Sir Gawain and the Green Knight*, one of the best-known medieval romances, was written by an unknown English author in the late 1300's.

The greatest English poet of the late 1300's was Geo frey Chaucer. Chaucer drew many of his themes and techniques from French, Italian, and Latin sources. He composed many love poems and *The Canterbury Tale* (about 1387-1400), an unfinished collection of 24 loosel related stories.

Renaissance poetry refers to the poetry written in Europe from about 1450 to 1650. This poetry appeared during the Renaissance, an era of outstanding cultural achievement in Europe (see **Renaissance**). Different styles and forms of poetry became popular during this period. Many of the new developments took place in France and Italy during the second half of the 1400's. Poets in those countries used such lyric forms as *madi gals* and *pastorals*. Madrigals usually deal with love an can be set to music. Pastorals portray shepherds or country life.

The new ideas in poetry spread to England in the early 1500's. Two English poets, Sir Thomas Wyatt and the Earl of Surrey, introduced several of the new style into English literature. These styles included a 12-sylla ble line called *alexandrine;* the Italian sonnet; and the *terza rima*, a three-line stanza form made famous by Dante in *The Divine Comedy*.

The language used in Renaissance poetry also differed from that of earlier poetry. Most medieval poets had written in Latin. By the 1500's, however, many writ ers had begun to use their native language, such as Ita ian or English. In Paris, a group of seven poets called th Pléiade helped establish French as the standard language for French poetry. See **French literature** (The Pléiade).

English poets of the late 1500's produced many out standing works. One of these works was *The Faerie Queene*, a six-book epic by Edmund Spenser. The firs three books appeared in 1590, and the second three i 1596. Other major English poetry of the late 1500's included the sonnets of Michael Drayton, William Shak speare, Spenser, and Philip Sidney.

The two major groups of English poets during the 1600's were the *metaphysical poets* and the *Cavalier poets*. The metaphysical poets included Richard Crashaw, John Donne, George Herbert, and Andrew Marvell. These poets often created elaborate images called *conceits*. The roughened language and irregul meters used by the metaphysical poets have had eno mous influence on poets of the 1900's.

The Cavalier poets became known for highly polisl love poems. These poets included Thomas Carew, Ro ert Herrick, Ben Jonson, Richard Lovelace, and Sir Joh Suckling. Their verse has regular meters and flowing patterns of sound.

Dramatic poetry also flourished in England during 1500's and 1600's. Important English dramatic poets o

his period included Christopher Marlowe and Shake-peare. Marlowe wrote powerful tragedies, such as *'amburlaine the Great* (about 1587) and *The Tragical Hisory of Doctor Faustus* (about 1588). Shakespeare wrote t least 37 plays from about 1590 to 1613.

The last great English Renaissance poet was John Milon, who wrote lyrics and epics. By the time his epic nasterpiece, *Paradise Lost,* appeared in 1667, a new age ıf poetry—the *neoclassical period*—had begun.

Neoclassical poetry dominated English poetry from bout 1660 to 1800. It tried to recapture many of the litrary ideals of such classical Roman poets as Horace,)vid, and Virgil. These poets lived during the time of ıe Roman emperor Augustus, who reigned from 27 .C. to A.D. 14. As a result, neoclassical poetry is somemes called *Augustan poetry.* Neoclassical poets comosed structurally balanced verse that expressed emoons in refined, restrained ways. They used elegant ınguage and wrote with humor and wit.

The most widely used neoclassical verse form was ıe *heroic couplet,* two rhymed lines of iambic pentamter. Jean Racine and Molière, two French playwrights f the 1600's, used this form in their dramas.

The English poets John Dryden and Alexander Pope lso used the heroic couplet. Dryden was the leading nglish poet of the late 1600's. He wrote *occasional oems* (poems that celebrate particular events), dramas, nd satires. He also translated Greek and Roman clascs. Pope, the finest English poet of the early 1700's, lso wrote satires and translated classics.

Romantic poetry is said to have begun in 1798 with ıe publication of *Lyrical Ballads,* a collection of poems y the English poets William Wordsworth and Samuel aylor Coleridge. In the preface to the second edition of ıis work, published in 1800, Wordsworth defined pory as "the spontaneous overflow of powerful feelings." ıis notion contrasted markedly with the neoclassical eal of controlled, restrained poetry. Wordsworth arued that good poetry results only from the imaginative cpression of emotions that the poet has actually experiıced. The romantic style came to reflect Wordsworth's ews.

Most romantic poets used simple language and rote about common subjects, such as nature and the :tivities of daily life. Many romantic lyrics were written though the poet is speaking. Such lyrics enabled the ›et to express thoughts and feelings directly.

In addition to Wordsworth and Coleridge, the princiıl English romantic poets included William Blake, Lord ron, John Keats, and Percy Bysshe Shelley. Many ›ets of other countries also wrote in the romantic ›irit. They included Johann von Goethe of Germany, ctor Hugo of France, Giacomo Leopardi of Italy, and exander Pushkin of Russia.

Victorian poetry. Victoria reigned as queen of Great itain from 1837 to 1901. British poetry written during :s period is called *Victorian poetry.* Victorian poets ed many of the forms and some of the themes of the mantic poets. However, their works also reflected inlectual and social changes that occurred in England a result of rapid industrialization and a new theory of olution.

In 1859, the English biologist Charles Darwin pubhed his theory of evolution in *The Origin of Species.* In this book, Darwin stated that every species of life had developed from an earlier one. Darwin thus challenged long-standing religious beliefs that every species had been created separately by divine act. Many people came to doubt their traditional values. Victorian poetry reflects this loss of faith. Expanding industrialization brought new prosperity to the English middle and upper classes, while the working class suffered in wretched poverty. Many Victorian poets dealt with the contrast between the lives of the rich and the poor.

Matthew Arnold, Robert Browning, and Lord Tennyson were the most highly regarded poets of the Victorian Age. Other leading poets included Dante Gabriel Rossetti, Christina Rossetti, and Algernon Charles Swinburne.

Beginnings of modern poetry. During the second half of the 1800's, a literary movement called *symbolism* developed in France. This movement greatly influenced poetry of the 1900's. The symbolists believed that the true nature of things exists more in the mind than in appearances. Symbolist poets used images, symbols, and the musical quality in words to suggest a connection between the visible and invisible worlds.

Charles Baudelaire was the first major French symbolist poet. His collection *Flowers of Evil* (1857) was one of the first works of symbolist poetry. Baudelaire's followers included the French poets Stéphane Mallarmé, Arthur Rimbaud, and Paul Verlaine.

Poets of the 1900's were also influenced greatly by the American poets Walt Whitman and Emily Dickinson and the English poet Gerard Manley Hopkins. Although these three poets lived in the 1800's, their work had elements that became associated with modern poetry. Whitman used everyday dialect in his poems, many of which were written in free verse. His collection *Leaves of Grass,* first published in 1855, is one of poetry's landmark works. Dickinson wrote remarkably powerful and imaginative poetry that features concentrated language, familiar subjects, and original variations of traditional meters. Hopkins showed how sound patterns can unify a poem and how sound affects the imagination.

Poetry of the 1900's has ranged widely in style and form. Much of the poetry is free verse and moves with the varied rhythms of everyday speech. The *imagists,* a group of English and American poets who became important during the early 1900's, helped popularize the use of varied rhythms. They also emphasized sharp, clear images in their works. The imagists were led by the American-born poet Ezra Pound.

Two of the most influential poets of the 1900's were William Carlos Williams of the United States and the American-born T. S. Eliot. Williams wanted poetry to be more like spoken language. The rhythms of his verse were determined by the feelings and ideas of a poem rather than traditional poetic forms. Eliot, who became a British citizen, also departed from conventional techniques. His complicated long poem *The Waste Land* (1922) is one of the most important works of modern poetry. Its jagged style and odd combinations of words, ideas, and symbols set a new direction for poetry.

During the 1950's and 1960's, many poets used frankly autobiographical material in their works. American poets called *beats* condemned middle-class life and attacked what they believed to be social and political in-

justice. Two prominent beat poets were Allen Ginsberg and Lawrence Ferlinghetti. *Confessional poets* wrote about intimate personal experiences, such as sexuality and mental illness. These poets included Robert Lowell, Sylvia Plath, and Anne Sexton of the United States.

From the early 1900's through the 1960's, traditional poetic forms also thrived. Major poets who used conventional language and forms included the English-born W. H. Auden; Dylan Thomas of Wales; William Butler Yeats of Ireland; and Robert Frost, John Crowe Ransom, and Wallace Stevens of the United States.

The leading poets of the 1960's through the 1980's represented an incredible range of style, form, and content. They included Margaret Atwood of Canada and Robert Creeley, Jorie Graham, Donald Justice, Galway Kinnell, Denise Levertov, W. S. Merwin, Adrienne Rich, William Stafford, Robert Penn Warren, and Richard Wilbur of the United States. In other countries, they included Ted Hughes and Philip Larkin of the United Kingdom, Odysseus Elytis of Greece; Eugenio Montale of Italy; Octavio Paz of Mexico; Czesław Miłosz of Poland; and Yevgeny Yevtushenko of the Soviet Union.

In the 1980's and 1990's, American poetry was characterized by the increasing recognition of poets from traditionally underrepresented groups, such as women, Native Americans, and African Americans. These poets included Leslie Marmon Silko, Rita Dove, and Gary Soto.

Paul B. Diehl

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Meter (poetry)	Rhythm

Outline

I. Kinds of poetry
- A. Lyric poetry
- B. Narrative poetry
- C. Dramatic poetry

II. The elements of poetry
- A. Rhythm and meter
- B. Sounds
- C. Imagery
- D. Forms

III. History

Questions

What are the three main kinds of poetry?
How did the Christian church influence the development of poetry during the Middle Ages?
What is the difference between rhythm and meter?
How do neoclassical poetry and romantic poetry differ?
What is a *dramatic monologue*?
What are the chief types of meter used for poetry in English?
How do epics differ from ballads?
What is *alliteration*? *Consonance*? *Assonance*?
Who were the *imagists*? The *beats*?
What is *blank verse*? *Free verse*?

Additional resources

Level I

For a wide selection of poetry works for this level, see the Poetry section of the Literature for children article. All these works are for younger readers.

Level II

Bugeja, Michael J. *Poet's Guide: How to Publish and Perform Your Work.* Story Line, 1995.
Dobyns, Stephen. *Best Words, Best Order.* St. Martin's, 1996.
Hollander, John, ed. *Committed to Memory: 100 Best Poems to Memorize.* Turtle Point, 1996.
Lies, Betty B. *The Poet's Pen: Writing Poetry with Middle and High School Students.* Teacher Ideas, 1993.
McCosker, Karen, and Albery, Nicholas, eds. *A Poem a Day.* Steerforth, 1996.
Milosz, Czeslaw, ed. *A Book of Luminous Things: An International Anthology of Poetry.* Harcourt, 1996.
Parini, Jay, ed. *The Columbia Anthology of American Poetry.* Columbia Univ. Pr., 1995.
Perry, Aaren Y. *Poetry Across the Curriculum: An Action Guide for Elementary Teachers.* Allyn & Bacon, 1997.
Woodring, Carl, and Shapiro, James, eds. *The Columbia Anthology of British Poetry.* Columbia Univ. Pr., 1995.

Poets' Corner. See Westminster Abbey.

Pogrom. See Genocide; Jews (The growth of anti-Semitism).

Poincaré, *pwan ka RAY,* **Raymond,** *ray MAWN* (1860-1934), served four times as premier of France, and was president of France from 1913 to 1920. He was a strong leader and gained a reputation as a clever financier and an ardent nationalist.

Poincaré first became premier of France in 1912 and tried to strengthen French alliances. In 1922, after his term as president of France ended, he became premier again. The Treaty of Versailles, which ended military actions against Germany in World War I (1914-1918), required Germany to pay *reparations* (compensation for war damages) to France. In 1923, after the Reparations Commission declared Germany in default, Poincaré ordered French troops into the Ruhr to force Germany to

pay (see **Ruhr** [History]). Poincaré was defeated in the 1924 elections and resigned as premier.

Poincaré served as premier again from 1926 to 1928, during a financial and political crisis. His efforts to revive the economy won him the title "savior of the franc." He resigned in 1929, after a fourth premiership. Poincaré was born in Bar-le-Duc, France. John F. Sweets

Poinciana, *POYN see AN uh,* is the name of several species of tropical flowering trees. The most important species, the *royal poinciana,* is native to Madagascar but has been widely planted in warm climates because of its



© E. R. Degginger

Flowers of the royal poinciana grow in immense clusters on the tree's branches, shown here. Royal poincianas grow along many roads in southern Florida and the West Indies.

immense clusters of brilliant flowers. Each flower is from 3 to 4 inches (8 to 10 centimeters) across, with 5 widely spreading red petals. One of these petals is streaked and dotted with yellow. The tree produces purplish-brown seed pods that may be more than 2 feet (60 centimeters) long. The pods contain hard, oblong beans. In some countries, people burn the pods as fuel.

The royal poinciana has lacy, fernlike leaves, divided into many leaflets. The strong, gnarled trunk with its spreading branches may grow 40 feet (12 meters) high.

An unrelated species, the *dwarf poinciana,* is a shrub native to tropical America. The shrub has fernlike leaves and clusters of reddish-yellow blossoms that grow at the ends of long, slender stalks. Walter S. Judd

Scientific classification. Poincianas belong to the pea family, Fabaceae or Leguminosae. The scientific name for the royal poinciana is *Delonix regia.* The dwarf poinciana is *Caesalpinia pulcherrima.*

Poinsettia, *poyn SEHT ee uh* or *poyn SEHT uh,* is a popular house plant often used as a Christmas decoration. It has tiny yellow flowers surrounded by large, colored *bracts* (modified leaves). These bracts resemble flower petals and are commonly bright red. Some poinsettia bracts are pink, white, or other colors.

Poinsettias are native to Mexico. A wild poinsettia r y grow 2 to 15 feet (0.6 to 4.6 meters) tall. It begins to bloom when days become shorter in the fall. During long summer days, the plant remains a green shrub. I cold climates, people must keep poinsettias indoors potted plants. A potted poinsettia grows 1 to 4 feet (3 120 centimeters) tall.

The poinsettia was named for Joel R. Poinsett, who came the first United States ambassador to Mexico in 1825. He introduced the plant to the United States wh he returned home. Other common names for the poi settia include the Christmas flower, lobster flower, ar Mexican flame leaf. The plant's hollow stems contain milky sap that can irritate the skin and eyes.

Paul Ecke III

Scientific classification. The poinsettia belongs to the spurge family, Euphorbiaceae. Its scientific name is *Euphorb pulcherrima.*

See also **Flower** (picture: Poinsettias); **Leaf** (picture: Bright red bracts).

Pointer is a dog used to hunt quail and other game birds. The dog is called *pointer* because it stops as st as a statue when it smells a bird, and *points* by facing the direction of the bird, often with one of the front paws lifted and its tail held out stiffly behind. The poi er is classed as a sporting dog and as a field dog, alo with setters, spaniels, and retrievers. Setters, spaniels and retrievers usually have long hair, but the pointer a a short, smooth coat. The pointer stands from 23 to 2 inches (58 to 71 centimeters) high at the shoulder and weighs from 45 to 75 pounds (20 to 34 kilograms). Its coat is white with patches of lemon, *liver* (reddish-brown), black, or orange. The pointer has speed and keen sense of smell. It is popular in America and England for hunting and field trails.

Critically reviewed by the American Pointer Club

See also **Dog** (picture: Sporting dogs).

Pointillism. See **Seurat, Georges; Painting** (Postimpressionism).

Poison is a substance that causes injury or illness when introduced into the body. Poisons may be swallowed, inhaled, injected, or absorbed by the skin or body membranes. The study of poisons is called *toxicology.*

The most potent poisons are usually found only in laboratories. They cause few deaths because they seldom occur in everyday surroundings. Most deaths a caused by weaker poisons contained in common hou hold products. About 1 million to 2 million human be ings suffer from poisoning each year in the United States, and several thousand deaths result. Many poi sonings take place when people fail to pay attention labels and instructions on containers of chemical sub stances. Poisons found in farm and household produ cause most poisonings and deaths in the United Stat These products include insect sprays, rat poisons, cl ing and polishing compounds, and such fuels as gas line. Even detergents have caused fatal poisonings w swallowed. A person also may be poisoned by impr erly taking medications, by abusing such substances alcohol, or by taking mind-altering drugs, such as co caine and heroin.

To avoid poisonings, never eat untested foods, su as wild mushrooms or berries, or foods in unlabelec

containers. Keep all medicines and chemicals out of the reach of small children. Children are more sensitive to poison than adults, and a smaller amount may cause a child's death.

Poison control centers have been set up in many hospitals to give emergency information to doctors and the public. They furnish first-aid information and advise physicians and emergency personnel on the appropriate *antidote.* An antidote is a substance that relieves the harmful effects of poisons.

Poisons can be useful and even lifesaving. Useful medicines, such as *curare* and *ouabain,* were discovered because they were used first as poisons on arrows. Ouabain is similar to the drug *digitalis* (see **Digitalis**).

Fungi, plant, and animal poisoning. Poisons produced by living organisms are called *toxins.* Some fungi produce toxins that are dangerous to human beings when swallowed in infested food. For example, some mushrooms have a toxic effect when they are eaten.

Many plants, such as larkspur and poison ivy, produce toxins that can be dangerous for human beings and livestock. Plant roots, stems, leaves, seeds, and fruits may contain poison.

Many animals have poisonous bites or stings. These include bees, wasps, scorpions, snakes, spiders, octopuses, and snails. Most animals use their poison to defend themselves or to hunt prey. Some fish, such as stingrays, have poisonous spines. Some salamanders, frogs, and toads have poison in their skin. For more information, see the *World Book* articles on **Snakebite** and each of the above animals.

Kinds of poisons. Scientists classify poisons in many different ways. A common classification lists five kinds: (1) corrosive poisons, (2) irritant poisons, (3) systemic poisons, (4) poisonous gases, and (5) poisonous foods.

Corrosive poisons destroy living tissue that they touch. Hydrochloric acid, nitric acid, and *sodium hydroxide* (lye) are corrosive poisons. A person who swallows this type of poison may destroy the tissues in his or her mouth and throat.

Irritant poisons cause *inflammation* (swelling and soreness) of the mucous membranes. These membranes line many air passages of the body, such as the nose. Irritants also affect the stomach, intestines, and nerve centers. Arsenic, lead, and most of the metallic poisons are irritant poisons. Arsenic causes vomiting and may affect the heart, kidneys, and other organs.

Systemic poisons attack the nervous system and other important organs, such as the kidneys, liver, and heart. Strychnine, a common rat poison, causes convulsions and difficulty in swallowing. Hydrocyanic acid and overdoses of heroin and cocaine may cause death. Poison from the belladonna plant produces hot flashes, thirst, and *delirium* (disorder of the mind). Many sedatives, such as barbiturates, are systemic poisons when taken in large doses. In addition, bites from some snakes, insects, and spiders can cause systemic poisoning.

Poisonous gases make breathing difficult and can cause death. Some poisonous gases, such as carbon monoxide from automobiles and gas heaters, are especially dangerous because they are difficult to notice at first. A number of poisonous gases irritate the lungs, eyes, nose, or skin.

Food poisoning can come from eating certain chemicals or organisms and their toxins. Chemicals, such as insecticides, and plants and animals, such as hemlock and certain shellfish, can cause food poisoning.

Botulism, poisoning caused by a toxin produced by bacteria, can cause paralysis and death.

Critically reviewed by the American Red Cross and Frank Welsch

Related articles in *World Book* include:

Poison gas. See **Chemical-biological-radiological warfare; Gas mask; Fumigation.**

Poison ivy is a kind of harmful vine or shrub in the cashew family. It grows plentifully in parts of the United States and southern Canada. Poison ivy usually grows as a vine twining on tree trunks or straggling over the ground. But the plant often forms upright bushes if it has no support to climb upon. Plants related to poison ivy include *poison oak,* which grows throughout much of Pacific North America and in parts of the eastern United States, and *poison sumac,* which grows in the eastern United States. Poison oak and poison sumac both are shrubs.

The tissues of all these plants contain a poisonous oil somewhat like carbolic acid. This oil is extremely irritating to the skin. It may be brushed onto the clothing or skins of people coming in contact with the plants. Many people have been poisoned merely by taking off their shoes after walking through poison ivy. People also can get poisoned from other people, but only if the oil remains on their skin. The eruptions themselves are not a source of infection.

Appearance. The leaves of poison ivy are red in early spring. Later in spring, they change to shiny green. They turn red or orange in autumn. Each leaf is made up of three leaflets more or less notched at the edges. Two of the leaflets form a pair on opposite sides of the leafstalk, while the third stands by itself at the tip of the leafstalk. Small greenish flowers grow in bunches attached to the



WORLD BOOK illustration by Lorraine Epstein

Poison ivy has leaves that consist of three leaflets. They contain a poisonous oil that irritates the skin. The plant's white, berrylike fruit also is poisonous.

main stem close to where each leaf joins it. Later in the season, clusters of poisonous, berrylike drupes form. They are whitish, with a waxy look.

Control and treatment. Efforts have been made to destroy these plants by uprooting them or by spraying them with chemicals. But poison ivy and poison oak are so common that such methods have not been very effective in eliminating them. Contact with the plants should be avoided.

After the oil has touched the skin, it usually takes some time for it to penetrate and do its damage. Before this happens, it is wise to wash the skin thoroughly several times with plenty of soap and water. Care should be taken not to touch any part of the body, for even tiny amounts of the oil will cause irritation. If poisoning develops, the blisters and red, itching skin may be treated with dressings of calamine lotion, Epsom salts, or bicarbonate of soda. Jerry M. Baskin

Scientific classification. Poison ivy, poison oak, and poison sumac belong to the cashew family, Anacardiaceae. Poison ivy is classified as *Rhus radicans* or *Toxicondendron radicans.* Poison oak is *R. diversiloba* or *T. diversilobum* and poison sumac is *R. vernix* or *T. vernix.*

See also **Poison oak; Sumac; Virginia creeper**.

Poison oak is a plant related to poison ivy and poison sumac. It grows as a bush or vine. The leaves of poison oak usually consist of three leaflets. Each leaflet has several lobes and may resemble the leaf of the white oak tree. Small greenish or yellowish flowers and hairy, berrylike, light-colored fruits cluster at the point where the leafstalk joins the stem.

Two species of poison oak live in North America. *Eastern poison oak* grows from Long Island, New York, to northern Florida and west to West Virginia, Texas, and southern Kansas. *Western poison oak* grows from the Lower California peninsula in Mexico to British Columbia in Canada.

Poison oak has sap that can irritate the skin. All parts of the plants contain the sap. In case of contact with poison oak, wash the affected areas immediately and thoroughly with soap and water. If such symptoms as blisters or swelling are severe, see a physician.

Jerry M. Baskin

Scientific classification. Poison oak belongs to the cashew family, Anacardiaceae. The scientific name for eastern poison oak is *Toxicodendron pubescens.* Western poison oak is *T. di-versilobum.*



WORLD BOOK illustration by Bridgette James, Wildlife Art Ltd.

Western poison oak can grow as a bush. Its leaves usually consist of three leaflets. This kind of poison oak grows from the Lower California peninsula in Mexico to British Columbia in Canada.

See also **Leaf** (illustration: Leaf edges).

Poison sumac. See **Sumac**.

Poisonous plant is any plant that is injurious to human beings or to animals. There are many kinds of poi sonous plants. Some kinds are merely unwholesome, are only moderately poisonous. Others contain substances that are among the deadliest poisons.

About 700 kinds of poisonous plants grow in the United States and Canada. Many look, smell, or taste d agreeable, and so people and animals avoid them. But even familiar food plants may have poisonous parts. F example, the leaves of potato and rhubarb plants are poisonous, as are the pits of apricots, cherries, and peaches. People should never eat or even chew any p of a plant that they do not know is harmless. In case of possible poisoning, a physician or a poison control ce ter should be called immediately.

The deadliest plant poison occurs in the seeds of th rosary pea. Craftworkers in many parts of the world us these pretty red-and-black seeds in making bracelets, necklaces, and rosaries. A person can be killed by eati one rosary pea seed. Another powerful poison occurs the oleander plant. Some people have died from eatin meat roasted on an oleander stick. Many have been killed by eating poisonous mushrooms, which cannot easily be distinguished from edible species. Poisonou plants have also killed many farm animals.

Not all poisonous plants do their harm by being eat en. Some, such as poison ivy and manchineel, irritate the skin or eyes. Certain others, known as *allergens,* a harmful only to people who are sensitive, or allergic, t them. The pollen of ragweed is an allergen that cause hay fever and asthma. See **Allergy**.

Some families of flowering plants contain many ve poisonous species. For example, the spurge family, Eu

Some poisonous plants

Name	Poisonous plants
Aconite (Monkshood)	Flowers, leaves, roots
Azalea	Entire plant
Belladonna	Entire plant, especially berries
Castor bean (Castor-oil plant)	Seeds
Chinaberry	Berries
Daphne	Bark, berries
Death camas	Bulbs
Foxglove	Entire plant
Gelsemium (Jessamine)	Entire plant
Hyacinth	Bulbs
Jimson weed (Datura)	Entire plant
Mistletoe	Berries
Mountain laurel	Entire plant
Mushrooms, poisonous	Entire plant
Narcissus	Bulbs
Nightshade	Entire plant, especially u ripe berries
Oleander	Entire plant
Poison hemlock	Leaves, roots, seeds
Potato	Green parts, spoiled tub
Rhododendron	Entire plant
Rhubarb	Leaves
Tobacco	Leaves
Water hemlock (Cowbane, Snakeroot)	Roots, young leaves
Yew	Bark, needles, seeds

horbiaceae, includes the cassava, croton, and the cas-or-oil plant, all poisonous. The nightshade family, olanaceae, includes such wholesome vegetables as the omato, potato, and eggplant. But it also contains such leadly members as belladonna, henbane, jimson weed, ind several kinds of nightshades. Several exceedingly oisonous plants, including aconite, larkspur, and helle-ore, belong to the crowfoot family, Ranunculaceae.

People make use of many kinds of poisonous plants. ome are lovely garden flowers. Others are used in naking insecticides. Many of the most valuable drugs ised in medicine are poisons extracted from plants and jiven in controlled doses. They include aconite, at-opine, cocaine, digitalis, hyoscine, morphine, quinine, ind strychnine. Jerry M. Baskin

Related articles in *World Book* include:

Aconite	Hemlock	Locust	Poison ivy
Alkaloid	Henbane	Mistletoe	Poison oak
Belladonna	Jack-in-the-pulpit	Mountain laurel	Pokeweed
Cassava	Jimson weed	Mushroom	Ragweed
Castor oil	Larkspur	Nicotine	Rhubarb
Digitalis	Locoweed	Oleander	Sumac
Dogbane			
Hellebore			

Poitier, *PWAH tee ay,* **Sidney** (1927-), is an American motion-picture actor. He became the first African American to rise to the top in the film industry as a leading man rather than as a singer, dancer, or comedian. Poitier has appeared in a number of movies that deal realistically with racial problems in the United States. These films include *No Way Out* (1950), *The Blackboard Jungle* (1955), *Edge of the City* (1957), *Guess Who's Coming to Dinner* (1967), and *In the Heat of the Night* (1967). Poitier won an Academy Award for his performance in *Lilies of the Field* (1963).

© Columbia Pictures

Sidney Poitier

Poitier was born in Miami and grew up in the Bahamas. About 1945, he began taking acting lessons at the American Negro Theater in New York City. He appeared on the Broadway stage in *Anna Lucasta* (1948) and *A Raisin in the Sun* (1959). His other films include *Cry, the Beloved Country* (1952), *Porgy and Bess* (1959), and *For Love of Ivy* (1968). Poitier also wrote two autobiographies, *This Life* (1980) and *The Measure of a Man* (2000). Louis Giannetti

Poitiers, *pwah TYAY,* **Battle of,** was fought in 1356, near the present French town of Poitiers. A famous English victory in the Hundred Years' War resulted from the Battle of Poitiers. The English forces were led by Edward, "the Black Prince" of England. King John II of France led the French troops. The English were greatly outnumbered, but the Black Prince fought skillfully. At the height of the battle the English horsemen suddenly appeared behind the French lines. The French fled, leaving King John II and his son Philip to be captured.

Two other famous battles took place at or near Poitiers. In 507, a Frankish king named Clovis defeated the Visigoths there. In 732, Charles Martel, another Frankish king, turned back Muslim invaders in fighting that began near Tours and ended near Poitiers. The 732 conflict, called the Battle of Poitiers or Battle of Tours, stopped the spread of Islam to Europe. Robert S. Hoyt

See also **Edward** (The Black Prince).

Poker is a card game in which players make bets on the cards they hold or hope to hold. There are two basic types of poker, *draw* and *stud*. In draw poker, each player is dealt five cards. Players may then discard unwanted cards and *draw* (receive) the equivalent number of new cards. Players bet both before and after the draw.

There are several forms of stud poker. In five-card stud, players are dealt one card facedown and one card faceup. Then players are dealt three additional cards faceup. Bets are placed after each round of cards is dealt. Seven-card stud games follow the same general rules except that players are each dealt seven cards. The best five-card hand out of the seven wins.

The following is the ranking of cards, from highest to lowest, for poker games in which the high hand wins:

Royal flush: A-K-Q-J-10 (all of one suit)

Straight flush: 2-3-4-5-6 (any five cards in sequence, all of one suit)

Four of a kind: 9-9-9-9-J (any four cards of the same value)

Full house: 8-8-8-J-J (any three of a kind plus a pair)

Flush: 4-7-9-J-K (any five cards of the same suit)

Straight: 7-8-9-10-J (any five cards in sequence from any suit)

Three of a kind: 6-6-6-4-Q (any three cards of the same value)

Two pairs: 7-7-10-10-5

One pair: J-J-7-9-A

Highest card: A-Q-9-8-4 beats A-Q-8-7-5

If two hands are of the same rank, the hand with the higher cards wins. Dwight Chuman

Pokeweed is a tall, branching perennial herb with greenish-white flowers and a red stem. It grows natively in waste places and along roadsides from Ontario to Florida, and west to Texas and Minnesota. It has been introduced into western North America and into other continents. Pokeweed grows 4 to 10 feet (1.2 to 3 meters) high. In fall, the berries ripen to a deep purple-black. The plant is known locally as *poke, scoke, pigeonberry, pokeberry, poke salet,* and *inkberry.*

The stems, leaves, seeds, and large fleshy roots of the pokeweed are poisonous. The plants must be cut off below ground level to kill them. The leafy sprouts are edible if cooked properly. The berries may be used as ink and food coloring. The roots and berries have been used to treat inflammation and skin diseases. Pokeweed is a source of several chemical compounds used in cancer research.

Donna M. Eggers Ware

Scientific classification. Pokeweed is in the pokeweed family, Phytolaccaceae. It is *Phytolacca americana.*



WORLD BOOK illustration by Lorraine Epstein

Pokeweed berries



J. Hagar, Robert Davis Productions



Horst Cerni, Supersto

Poland is a land of beautiful countryside and rapidly growing cities. Rolling hills and rugged mountains rise in southern Poland, *left*. Since the mid-1900's, many Poles have moved to towns and cities, such as Warsaw, *right*. Today, most of Poland's people live in urban areas.

Poland

Poland is a large nation in central Europe. It borders on the Baltic Sea. Warsaw is its capital and largest city.

Poland is named for the Polanie, a Slavic tribe that lived more than a thousand years ago in what is now Poland. The name *Polanie* comes from a Slavic word that means *plain* or *field*. Flat plains and gently rolling hills cover most of the country.

At one time, the people of Poland ruled an empire that stretched across most of central Europe. But foreign powers conquered and divided Poland and brought an end to its existence as a separate nation. In 1918, however, after more than a hundred years of foreign rule, Poland became an independent republic.

Poland experienced great economic, political, and social changes during the 1900's. Before World War II (1939-1945), Poland was largely agricultural, and most of the people were poor farmers. After the war, Poland began to develop into an industrial nation. Many people moved to the cities to take jobs in factories.

In the mid-1940's, Poland became a Communist country. The Communist Party controlled the Polish government and placed many restrictions on the freedom of the people. The party maintained power continuously until 1989, when Poland held its freest parliamentary elections since the Communists took control. Non-Communists took office for the first time since the 1940's. Restrictions on the freedom of the Polish people began to be lifted.

Janusz Bugajski, the contributor of this article, is Director of East European Studies at the Center for Strategic and International Studies in Washington, D.C.

Government

National government. Poland is a republic. Its current constitution went into effect in 1997.

The National Assembly is Poland's parliament. It has two houses. The lower house, called the Sejm, has 460 members. The upper house, or Senate, has 100 members. Members of both houses serve four-year terms.

Facts in brief

Capital: Warsaw.
Official language: Polish.
Official name: Rzeczypospolita Polska (Republic of Poland).
Area: 124,808 mi² (323,250 km²). *Greatest distances*—east-west, 430 mi (692 km); north-south, 395 mi (636 km). *Coastline*—277 mi (446 km).
Elevation: *Highest*—Rysy peak, 8,199 ft (2,499 m) above sea level. *Lowest*—sea level.
Population: *Estimated 2002 population*—38,835,000; density, 311 per mi² (120 per km²); *distribution*, 62 percent urban, 38 percent rural. *1988 census*—37,878,641.
Chief products: *Agriculture*—barley, hogs, potatoes, rye, sugar beets, wheat. *Manufacturing*—chemicals, food products, iron and steel, machinery, ships, textiles. *Mining*—coal, copper, silver, sulfur.
National anthem: "Jeszcze Polska nie Zginęla" ("Poland Has Not Yet Perished").
Money: *Basic unit*—zloty. One hundred groszy equal one zloty.

he duties of the National Assembly include passing ws and supervising the other branches of the govern- ent.

The president is the head of state. The president's owers include the ability to declare a state of emer- ency, to veto legislation (which may be overturned by e Sejm), and to dissolve the National Assembly. The resident is elected to a term of five years.

The Sejm appoints a Council of Ministers, which car- es out the operations of the government. The Council f Ministers includes a prime minister and a number of ther ministers. The prime minister is the head of the overnment.

Local government. Poland is divided into 16 *voivod- hips* (regions). A leader called a *voivod,* appointed by e prime minister, heads each region. The regions are ivided into *powiats* (districts), which are made up of *minas* (communities). Each region, district, and commu- ity has an elected council.

Politics. Poland's most important political organiza- ons include the Democratic Left Alliance, the Freedom nion, the Polish Peasant Party, and Solidarity Electoral ction. The Freedom Union and Solidarity Electoral Ac- on favor a free enterprise economy. Solidarity Electoral ction is the political arm of Solidarity, which is an or- anization of trade unions. The Democratic Left Alliance a Communist party, and its members are in favor of ore government control of the economy. The mem- ers of the Polish Peasant Party want agricultural reform aid small landowners, and they think Poland should low its move to a free enterprise economy.

Courts. The Supreme Court is the highest court of oland. The Council of State appoints Supreme Court idges to five-year terms. The judicial system also in- ludes province courts and county courts.

Armed forces. About 240,000 men serve in Poland's rmy, navy, and air force. Men may be drafted at age 19 serve 18 months of active duty in the armed forces.

People

Almost all of the people of Poland are Poles. They are escended from Slavic tribes that settled on the Vistula nd Warta rivers several thousand years ago. Polish, the fficial language, is related to Czech, Slovak, and other lavic languages.

Minority groups make up only a small percentage of e population. The largest minority groups are Belaru- ians, Germans, and Ukrainians.

Way of life

Housing. In the cities, most Polish families live in sim- le two- or three-room apartments. In rural areas, small rick or wooden cottages provide housing.

Food. Bread, pork, sausages, potatoes, apples, and lairy products are favorite foods. Meaty stews, hearty eet or cabbage soup, and mushrooms are popular. The olish people also enjoy rich pastries and fish, especial- y on holidays.

Recreation. Camping and hiking are some of the opular recreational activities in Poland. Poles also enjoy occer and other sports.

Religion. The Poles adopted Christianity in A.D. 966. hroughout their history, they remained loyal to the Ro- nan Catholic Church, though people in neighboring countries practiced Protestant or Eastern Orthodox reli- gions. During the 1800's, when Poland did not exist as a separate nation, loyalty to the Roman Catholic Church helped hold the Polish people together.

In the late 1940's and early 1950's, the country's Com- munist leaders tried to destroy the influence of the Ro- man Catholic Church in Poland. They restricted religious practices and imprisoned many priests. Polish Catholics resisted, however. In 1956, after antigovernment riots took place, the government discontinued most of its policies against the Roman Catholic Church. Today, Poles have complete freedom of religion.

A large majority of the people of Poland are Roman Catholics. There are thousands of Roman Catholic churches in the country as well as thousands of reli- gious instruction centers. The Roman Catholic Church also operates the Academy of Catholic Theology in War- saw and the Catholic University of Lublin. Religious mi- nority groups in Poland include Protestants, Muslims, Jews, and members of various Eastern Orthodox Churches.

Education. Poles have a long tradition of respect for education. Polish scholars, such as the astronomer Nico- laus Copernicus, have made important contributions in many fields. The first Polish university, the University of Kraków (now Jagiellonian University), was founded in 1364. Poland established a government ministry of edu-





Poland's national flag, flown by the people, *left,* has red and white stripes.The state flag, used by the government, includes the coat of arms, *right.* An eagle has been used on the Polish coat of arms since the 1200's.



WORLD BOOK map

Poland is a country in central Europe. Its central location has contributed to many boundary changes throughout its history.



Poland map index

Provinces

Dolnośląskie ....D 2
Kujawsko-
  Pomorskie ....C 4
Łódzkie ....D 4
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Małopolskie ....F 4
Mazowieckie ....C 5
Opolskie ....E 3
Podkarpackie ....F 6
Podlaskie ....B 6
Pomorskie ....A 3
Śląskie ....E 4
Świętokrzyskie ....E 5
Warmińsko-
  Mazurskie ....A 5
Wielkopolskie ....C 3
Zachodnio-
  Pomorskie ....B 2

Cities and towns

Aleksandrów
  Łódzki* ......20,100 ..C 4
Andrychów* ....23,000 ..F 4
Augustów ......28,900 ..B 6
Bartoszyce ......25,700 ..A 5
Będzin* ....75,800 ..E 4
Bełchatów ......59,300 ..D 4
Biała
  Podlaska ......54,100 ..C 6
Białogard ......24,300 ..A 2
Białystok ......273,300 ..B 6
Bielawa ....34,500 ..E 2
Bielsk ....27,200 ..C 6
Bielsko-Biała ..184,400 ..F 4
Bierún* ....21,900 ..E 4
Biłgoraj ....26,500 ..E 6
Bochnia ....29,500 ..F 5
Bogatynia* ......19,000 ..E 2
Bolesławiec ....44,400 ..D 2
Braniewo ......18,000 ..A 4
Breslau, see
  Wrocław
Brodnica ....26,800 ..B 4
Brzeg ....39,100 ..E 3
Busko-Zdrój ....18,100 ..E 5
Bydgoszcz ....383,600 ..B 3
Bytom ....232,200 ..E 4
Chełm ....67,700 ..D 7
Chełmno ....21,600 ..B 4
Chodziez ....20,100 ..B 3
Chojnice ....38,900 ..B 3
Chorzów ......131,500 ..E 4
Chrzanów ......42,800 ..E 4
Ciechanów ......44,700 ..C 5
Cieszyn ....37,300 ..F 4
Czechowice-
  Dziedzice ......35,800 ..F 4
Czeladź* ....37,400 ..E 4
Czerwonka-
  Leszczyny* ....30,500 ..E 4
Częstochowa ..258,700 ..E 4
Dabrowa
  Górnicza* ....139,200 ..E 4
Danzig, see
  Gdańsk
Dębica ....47,800 ..E 5
Dęblin* ....19,300 ..D 6
Działdowo ......20,300 ..B 5
Dzierżoniów ....38,000 ..E 2
Elblag ....126,900 ..A 4
Ełk ....53,800 ..B 6
Gdańsk
  (Danzig) ....466,500 ..A 4
Gdynia ....251,800 ..A 4
Giżycko ....29,400 ..A 6
Gliwice ....215,700 ..E 4
Głogów ....73,900 ..D 2
Gniezno ....70,600 ..C 3
Goleniów ....22,300 ..B 1
Gorzów Wiel-
  kopolski ......125,200 ..C 2
Gostyń* ....20,000 ..C 3
Gostynin ....19,800 ..C 4
Grajewo ....21,600 ..B 6
Grodzisk Maz-
  owiecki* ......24,700 ..C 5

Place	Population	Map key
udziadz	102,900	B 4
yfice	17,600	A 2
yfino	21,100	B 1
jnówka	24,100	C 7
ubieszów	19,900	E 7
wa	32,100	B 4
owrocław	78,500	C 3
ocin	25,300	C 3
osław	42,400	E 6
ło	38,100	F 5
strzebie-Zdrój	104,600	F 4
wor	25,100	D 2
worzno*	99,900	E 4
drzejów	18,200	E 5
ienia Góra	93,500	E 2
lisz	106,500	D 3
mienna Góra	23,500	E 2
towice	366,900	E 4
dzierzyn	71,300	E 3
trzyn	30,600	A 5
ty*	19,500	E 4
elce	215,000	E 5
odzko	30,600	E 2
uczbork	26,800	D 3
urów*	46,000	E 4
ło	23,500	C 4
łobrzeg	46,000	A 2
nin	81,100	C 3
ńskie	22,100	D 5
ścian	24,400	C 2
ścierzyna	22,800	A 3
szalin	109,800	A 2
zienice	21,200	D 5
aków	751,300	E 4
apowice*	19,900	E 3
aśnik	37,000	E 6
asnystaw	20,400	D 7
osno	50,100	F 6
otoszyn	28,200	D 3
tno	51,000	C 4
widzyn	37,400	B 4
sk*	19,900	D 4
ziska Górne*	23,400	E 4
bork	35,300	A 3
eczna	20,100	D 6
gionowo	50,800	C 5
gnica	106,100	D 2
szno	59,500	D 2
ódź	844,900	D 4
omża	60,700	B 6
owicz	31,000	C 4
bań	24,000	D 2
bartów	22,700	D 6
bin	83,000	D 2
blin	352,500	D 6
bliniec	26,000	E 4
boń	20,100	C 3
ków	31,700	C 6
albork	40,000	A 4
iędzyrzecz	20,300	C 2
ielec	63,300	E 5
ikołów*	37,300	E 4
ińsk Mazowiecki	34,500	C 5
ława	29,600	B 5
ragowo	22,600	B 5
ysłowice*	94,600	E 4
yszków	33,800	E 4
akło nad Notecia	20,100	B 3
owa Ruda	27,400	E 2
owa Sól	43,400	D 2
owy Dwór Mazowiecki	26,800	C 5
owy Sacz	79,000	F 5
owy Targ	33,000	F 4
ysa	47,800	E 3
ława	31,500	D 3
lenica	38,300	D 3
lkusz*	41,000	E 4
lsztyn	164,800	B 5
poczno	21,200	D 5
pole	128,900	E 3
rzeszo*	18,200	E 4
stróda	34,900	B 4
strołęka	51,800	B 5
strów Mazowiecka	21,100	C 6
strów Wielkopolski	74,000	D 3
strowiec Swiętokrzyski	79,600	D 5
święcim	45,100	E 4
twock	44,200	C 5
zorków	21,900	C 4
abianice	75,600	D 4
iaseczno*	24,700	C 5
iekary Slaskie*	68,500	E 4
iła	73,300	B 2
ionki	21,600	D 5
iotrków Trybunalski	81,000	D 4
iastów*	23,500	C 5
leszew	18,100	D 3
łock	125,300	C 4
łońsk	21,700	C 5
olice	35,000	B 1
Polkowice	21,100	D 2
Poznań	589,700	C 3
Prudnik	24,600	E 3
Pruszcz Gdański	21,500	A 4
Pruszków	53,200	C 5
Przemysl	69,200	F 6
Pszczyna*	39,900	E 4
Puławy	53,200	D 6
Pułtusk	18,200	C 5
Pyskowice*	21,900	E 4
Racibórz	65,300	E 3
Rawicz	21,100	D 3
Radom	229,700	D 5
Radomsko	50,700	D 4
Ruda Slaska	171,600	E 4
Rumia	38,000	A 3
Rybnik	144,800	E 4
Rzeszów	154,800	E 6
Sandomierz	24,700	E 6
Sanok	40,800	F 6
Siedlce	72,900	C 6
Siemianowice Slaskie*	81,200	E 4
Sieradz	43,600	D 4
Sierpc	19,500	C 4
Skarżysko-Kamienna	51,200	D 5
Skawina*	24,000	E 4
Skierniewice	46,700	C 5
Słupsk	102,400	A 3
Sochaczew	39,000	C 5
Sokółka	19,900	B 7
Sopot	45,800	A 4
Sosnowiec	259,000	E 4
Srem	28,600	C 3
Środa Wielkopolska	20,800	C 3
Stalowa Wola	71,000	E 6
Starachowice	56,900	D 5
Stargard Szczeciński	71,600	B 1
Starogard Gdański	49,800	A 4
Stettin, see Szczecin		
Strzelce Opolskie*	21,900	E 3
Suwałki	62,800	A 6
Swarzedz	23,400	C 3
Swidnica	63,800	E 2
Swidnik	40,600	D 6
Swiebodzice	24,800	E 2
Swiebodzin	22,400	C 2
Swiecie	26,600	B 3
Świetochłowice*	60,600	E 4
Świnoujście	43,600	A 1
Szczecin (Stettin)	414,200	B 1
Szczecinek	41,800	B 2
Szczytno	27,400	B 5
Tarnobrzeg	49,500	E 5
Tarnów	121,900	E 5
Tarnowskie Góry*	74,400	E 4
Tczew	59,900	A 4
Tomaszów Lubelski	20,800	E 7
Tomaszów Mazowiecki	69,900	D 4
Toruń	202,000	B 4
Turek	29,600	C 4
Trzebinia*	20,400	E 4
Tychy	138,800	E 4
Wadowice*	19,400	E 4
Wagrowiec	23,500	C 3
Wałbrzych	141,200	E 2
Wałcz	26,900	B 2
Warsaw (Warszawa)	1,653,300	C 5
Wielun	25,100	D 4
Wejherowo	47,100	A 3
Włocławek	122,800	C 4
Wodzisław Ślaski	112,200	E 3
Wołomin*	36,900	C 5
Wrocław (Breslau)	643,600	D 3
Września	28,300	C 3
Wyszków	24,600	C 5
Zabrze	205,800	E 4
Żagań	27,700	D 2
Zakopane	28,600	F 4
Zambrów	22,800	B 6
Zamość	63,100	E 7
Żary	40,500	D 1
Zawiercie	57,100	E 4
Zduńska Wola	45,400	D 4
Zgierz	59,200	D 4
Zgorzelec	36,500	D 1
Zielona Góra	114,900	C 2
Zory*	67,300	E 4
Żyrardów	43,000	C 5
Żywiec	32,000	F 4

*Does not appear on map; key shows general location.
Source: 1991 official estimates.

cation as early as 1773. Until the 1900's, however, education was reserved for only a small, privileged section of the population. Today, almost all adult Poles can read and write. For the country's literacy rate, see **Literacy** (table: Literacy rates).

Polish law requires children from age 7 to 15 to attend school. Most students attend free, government-operated schools. But an increasing number of students enroll in private schools.

After completing the elementary school program, students may attend vocational schools or four-year secondary schools. Secondary school graduates must then pass entrance examinations for entry into schools of higher education.

Poland has 12 universities. It also has many technical institutes and other specialized schools.

The arts. Poland has produced many outstanding artists, musicians, and writers. Cultural life in Poland flourished during the 1400's and 1500's. In the 1500's, the poets Mikołaj Rej and Jan Kochanowski were among the first writers to use the Polish language for their works.

Polish culture also flourished during the 1800's, when the Polish national identity was being threatened by the Germans and the Russians. The paintings of Jan Matejko portrayed scenes from Polish history. The composer Frédéric Chopin wrote many works based on Polish dances, such as the mazurka and the polonaise. Another composer and pianist, Ignace Jan Paderewski, became a leading Polish statesman. Outstanding Polish writers of the 1800's included the poet Adam Mickiewicz, the playwright Stanisław Wyspiański, and the novelist Henryk Sienkiewicz. Sienkiewicz won the Nobel Prize for litera-



Rhoda Sidney, Nancy Palmer Agency

Weddings and other family gatherings play an important role in the social life of Poles, especially those who live in rural areas. At the country wedding shown here, the bride's attendants are dressed in traditional Polish folk costumes.



© Steve Leonard, Black Star

Poles relax at a sidewalk cafe in the main square of Kraków, a city that has long served as a center of Polish cultural life. The towers of the Church of St. Mary rise in the background.

ture in 1905 for his works, which include the novel *Quo Vadis?* Another Polish novelist, Władysław Reymont, won the Nobel Prize for literature in 1924 for *The Peasants* and other novels. Two Polish poets have won Nobel Prizes for literature. Czesław Miłosz received the award in 1980, and Wisława Szymborska in 1996.

Many Poles have won fame in the graphic arts, especially in poster design. Movies are also a popular art form in Poland.

Beginning in the late 1940's, Poland's Communist leaders restricted cultural activity that did not promote Communist goals. But a series of antigovernment protests from the 1950's to the 1980's resulted in increases in cultural freedom. Today, there are few, if any, restrictions on cultural activities. The government has encouraged the preservation of traditional folk arts and music.

The land

Land regions. Poland can be divided into seven land regions: (1) the Coastal Lowlands, (2) the Baltic Lakes Region, (3) the Central Plains, (4) the Polish Uplands, (5) the Carpathian Forelands, (6) the Sudeten Mountains, and (7) the Western Carpathian Mountains.

The Coastal Lowlands extend in a narrow strip along the Baltic coast of northwestern Poland. Sandy beaches line much of the generally smooth coastline. The coast forms natural harbors at Gdańsk, Gdynia, and Szczecin. These three ports are the only major cities located in the lowlands.

The Baltic Lakes Region covers most of northern Poland. This scenic, hilly area has thousands of small lakes. Forests and peat bogs (swamps made up of decayed plants) cover parts of the area. Most of the land is not good for farming, though some farmers raise potatoes and rye. Lumbering is the most important industry. The Baltic Lakes Region is thinly populated. It is a popular vacation spot, where many Poles enjoy camping, hiking, and fishing.

The Central Plains stretch across the entire width of Poland south of the Baltic Lakes Region. The low-lying plains make up Poland's major agricultural area, though other regions have richer soil. Farmers in the plains grow potatoes, rye, sugar beets, and other crops. This region has several of Poland's most important cities, including Poznań, Warsaw, and Wrocław.

The Polish Uplands consist of hills, low mountains, and plateaus that rise south of the plains region. The densely populated uplands contain most of Poland's mineral wealth and much of its richest farmland. One of the world's largest coal fields lies around the city of Katowice. Coal-mining and metal-processing industries

© Chris Niedenthal, Black Star



Camping and hiking are popular recreational activities in Poland. Favorite camping areas are found in the Western Carpathian Mountains and the Baltic Lakes Region.



Elliott Erwitt, Magnum

Roman Catholicism has a strong influence on the life of most Poles. A large majority of the people of Poland belong to the Roman Catholic Church. This picture shows Catholics at an outdoor religious ceremony in the city of Częstochowa.

have made the Katowice area the most highly industrialized region in Poland. Copper, lead, and zinc are also found in the uplands. Fertile soil covers much of the area, especially in the east. Corn, potatoes, and wheat rank among the region's major crops.

The Carpathian Forelands lie within the branches of the Vistula and San rivers in southern Poland. Much of this region is densely populated. Crops thrive in the rich soil that covers parts of the gently rolling forelands. Iron and steel industries have developed around Kraków, the region's most important manufacturing center.

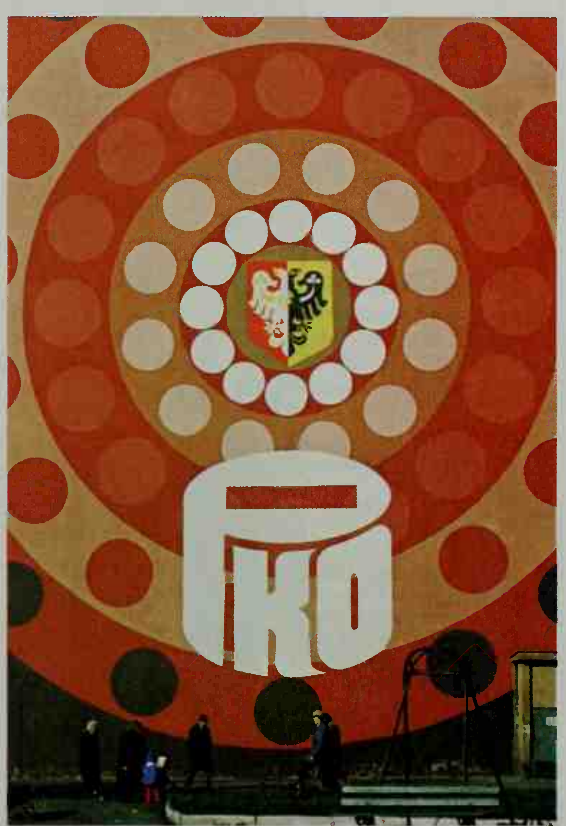
The Sudeten Mountains border southwestern Poland. Forests cover the rounded peaks of the Sudetens, most of which are located less than 5,000 feet (1,500 meters) above sea level. The valleys and foothills are used for crops and pastureland. Textile industries operate in a large number of the small cities and towns of the Sudeten Mountains.

The Western Carpathian Mountains form the southernmost region of Poland. These steep, scenic mountains rise up to 8,199 feet (2,499 meters) at Rysy peak, the highest point in Poland. Rural towns and villages are scattered throughout the region. Bears, wildcats, and other animals live in the thickly forested mountains, and the region has several national parks.

Rivers and canals form a network of navigable waterways in Poland. The longest river, the Vistula, flows 675 miles (1,086 kilometers) through Poland from the Western Carpathians to the Baltic Sea. Other important rivers include the Bug, the Oder, and the Warta.

Climate

The climate of Poland varies greatly from one part of the country to another. In general, the coast has milder weather than the inland regions, and the mountainous



Hervé Gloaguen, Woodfin Camp, Inc.

A huge poster in the city of Wroclaw serves as an advertisement for the National Bank of Poland. Many Polish artists have won widespread fame for their bold, colorful poster designs.

zones are cooler than the lowlands. Temperatures throughout the country average 26 °F (-3 °C) in January and 73 °F (23 °C) in July. The average annual *precipitation* (rain, snow, and other forms of moisture) totals 24 inches (61 centimeters).

Economy

Natural resources. Poland's most important natural resource is coal. One of the richest coal fields in the world lies in southern Poland. Poland also has deposits of copper, lead, salt, silver, sulfur, and zinc.

Farmland covers more than three-fifths of Poland. But much of the soil is of poor quality and must be fertilized. Forests cover about a fourth of the land.

Service industries are those economic activities that produce services, not goods. The leading employer among service industries in Poland is the community, social, and personal services group. It includes such economic activities as education, engineering, and health care. The second largest employer among Polish service industries is trade. Other service industries in-



Ed Barnas, DP

Gently rolling hills cover much of southern Poland. This area has much of the country's best farmland.

Poland
terrain map

International boundary
Land region boundary
Canal
Elevation above sea level
City or town

WORLD BOOK map

Baltic Sea
COASTAL LOWLANDS
BALTIC LAKES REGION
CENTRAL PLAINS
POLISH UPLANDS
CARPATHIAN FORELANDS
WESTERN CARPATHIAN MTS.
SUDETEN MTS.
RUSSIA
LITHUANIA
BELARUS
UKRAINE
SLOVAKIA
CZECH REPUBLIC
GERMANY
Gdańsk
Gdynia
Szczecin
Bydgoszcz
Toruń
Poznań
Warsaw
Łódź
Wrocław
Opole
Kraków
Katowice
Gliwice
Częstochowa
Kielce
Radom
Lublin
Rzeszów
Tarnów
Białystok
Olsztyn
Elbląg
Płock
Włocławek
Zielona Góra
Wałbrzych
1,079 ft. (329 m)
+2,008 ft. (612 m)
Rysy 8,199 ft. (2,499 m)

0 100 200 300 400 Miles
0 100 200 300 400 500 600 Kilometers

Physical features

Feature		
Baltic Sea	A	1
Barycz River	C	2
Biebrza River	B	5
Bóbr River	C	1
Brda River	B	2
Bug River	C	5
Drawa River	D	4
Drwęca River	B	3
Dunajec River	E	4
Góry Święto-krzyskie (range)	E	1
Gull of Gdansk	A	3
Gwda River	B	2
Lake Mamry	A	5
Lake Sniardwy	B	4
Liwiec River	C	4
Narew River	B	4
Neisse River	C	1
Nogat River	A	3
Notec River	B	2
Nysa Kłodzka River	D	2
Obra River	C	1
Oder River	C	1
Parseta River	A	2
Pilica River	C	4
Pomeranian Bay	A	1
Prosna River	C	2
Rysy (peak)	E	3
Stettin Lagoon	B	1
San River	D	5
Sudeten Mountains	D	2
Tatra Mountains	E	3
Vistula River	C	3
Vistula Lagoon	A	3
Warta River	C	3
Western Carpathian Mountains	E	3
Wieprz River	C	5
Wistoka River	E	4
Wkra River	B	4

ude transportation and communication, government, nd finance and insurance.

Manufacturing and mining. The chief manufactured roducts of Poland include chemicals, food products, on and steel, machinery, ships, and textiles. Poland nks among the leading countries in the production of oal and silver.

Agriculture. Poland ranks among the world's leading roducers of potatoes and rye. Other important crops clude barley, sugar beets, and wheat. Farmers roughout Poland raise hogs. Cattle and sheep are ised mainly in the hilly regions of the south.

International trade. Poland's leading trading partners include the United Kingdom, France, Germany, aly, and Russia. Its chief exports include coal, food roducts, machinery, ships, and sulfur. Poland imports otton, food products, iron ore, machinery, natural gas, etroleum, wool, and other goods.

Transportation. Poland has an extensive system of oads, but railroads provide the chief means of transportation in Poland. The railroad network links most Polh cities and towns. The chief seaports in Poland are dańsk, Gdynia, and Szczecin. Polish Airlines (LOT), the ountry's only airline, operates both domestic and international flights. Poland's chief airport is at Warsaw.

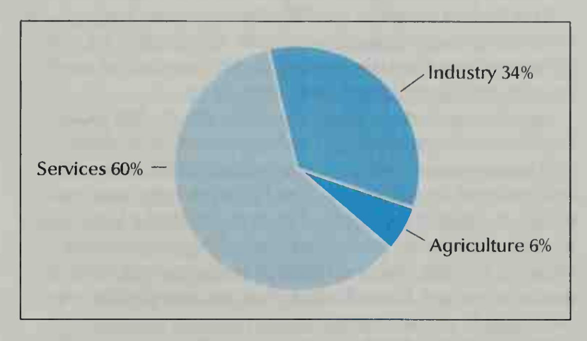
Communication. Poland publishes about 55 daily ewspapers. The leading newspaper, which is pubshed in Warsaw, is *Gazeta Wyborcza*.

History

As early as 2000 B.C., the area that is now Poland was habited by the ancestors of Slavic tribes. During the .D. 800's, several Slavic tribes united under the Polanie, ne of the largest groups in the area.

The early Polish state. Members of the Piast family ecame Poland's first rulers. By the mid-900's, Prince lieszko I ruled over most of the land along the Vistula nd Oder rivers. His son, Bolesław I, conquered part of hat is now the Czech Republic and parts of what are ow Germany, Slovakia, and Ukraine. In 1025, Bolesław as crowned the first king of Poland. After his death later that year, Poland went through periods of warfare nd disunity. By the mid-1100's, the country had broken p into several sections, each ruled by a different noble.

Poland's gross domestic product



The gross domestic product (GDP) is the total value of goods and services produced within a country in a year. The GDP measures a nation's economic performance and can be used to compare the economic output and growth of countries. Poland's GDP was $135,623,000,000 in 1997.

Production and workers by economic activities

Economic activities	Percent of GDP produced	Employed workers: Number of persons	Employed workers: Percent of total
Manufacturing & mining	26	3,570,000	24
Trade	22	2,202,000	14
Finance & insurance	11	752,000	5
Government	10	1,722,000	11
Community, social, & personal services	8	1,597,000	10
Construction	8	1,003,000	7
Agriculture & forestry	6	3,117,000	21
Transportation & communication	6	936,000	6
Utilities	3	273,000	2
Total	100	15,172,000	100

Figures are for 1997.
Sources: International Monetary Fund; International Labour Office.

During the 1200's, various peoples invaded and conquered parts of Poland. Most of the country was finally reunified in the early 1300's. Casimir the Great, the last Piast monarch, ruled Poland from 1333 to 1370. Casimir formed a strong central government, strengthened the

© Gregory Wrona, Panos Pictures



Retail trade is an important service industry in Poland and employs many people. The store shown here is part of a large shopping center built in Warsaw in the early 1990's.

economy, and encouraged cultural development.

The Polish empire. In 1386, Queen Jadwiga of Poland married Wladyslaw Jagiełło, the Grand Duke of Lithuania. Jagiełło ruled Poland and Lithuania, but each country remained largely self-governing.

Jagiellonian kings ruled Poland for nearly 200 years. Under their leadership, Poland expanded its territory and made important advances in its cultural, economic, and political development. The Polish empire reached its height during the 1500's, when it covered a large part of central and eastern Europe, including Belarus and Ukraine. In 1493, the first national parliament of Poland was established. Poland and Lithuania were united under a single parliament in 1569.

The decline of Poland. In spite of the advances of the Jagiellonian period, signs of strain developed in Poland after the mid-1500's. The monarchy began to lose power to the nobles, who dominated the parliament. After the death of the last Jagiellonian monarch in 1572, Polish kings were elected by the nobles. Some of the elected kings were foreigners, and these kings proved to be ineffective rulers.

Rivalries among the nobles weakened the Polish parliament, and costly wars ruined the economy. Poland lost much of its territory in Ukraine as a result of a rebellion that took place there in the mid-1600's. In 1655, Sweden won control over most of Poland's Baltic provinces. A series of wars with Turkey finally ended with a Polish victory at the Battle of Vienna in 1683.

The partitions. Poland's decline continued into the 1700's. In 1772, Austria, Prussia, and Russia took advantage of Poland's weakness and *partitioned* (divided) Polish territory among themselves. Austria seized land in southern Poland. Prussia took land located in western Poland. Russia took land in the east. As a result, Poland lost about a third of its territory and half its population.

After the first partition, the Polish government adopted a series of reform measures to stop the country's decay. In 1791, a new constitution restored the hereditary monarchy but also incorporated democratic procedures. However, the reforms came too late. In 1793, Prussia and Russia seized additional territory in eastern and western Poland. This second partition led to an uprising among Poles in 1794. Polish forces under Tadeusz Kościuszko fought Russian and Prussian troops but were defeated. Austria, Prussia, and Russia carried out the third partition of Poland in 1795, dividing what remained of the country among themselves. Poland no longer existed as a separate country.

After 1795, many Poles joined the French forces of Napoleon Bonaparte to fight against Austria and Prussia. In 1807, Napoleon gained control of Prussian Poland and made it into a Polish state called the Grand Duchy of Warsaw. But after Napoleon's final defeat in 1815, Poland was again divided among Austria, Prussia, and Russia. A small, self-governing Kingdom of Poland was established under Russian control.

The struggle against foreign rule. In 1830, Poles in the Kingdom of Poland rebelled against the Russians. But Russia crushed the revolt. Other unsuccessful revolts were launched against Austria and Prussia. After a second revolt in the Kingdom of Poland in 1863, Russia tried to destroy Polish culture by making Russian the official language there. After 1871, when Prussia formed the German Empire, Poles under Prussian control were forced to adopt the German language.

Poles under Austrian rule won some self-governmen[t] in the late 1800's. In the 1880's and 1890's, Polish politica[l] parties formed in all three parts of Poland. Leading politicians included Józef Piłsudski and Roman Dmowski.

World War I and independence. After the outbrea[k] of World War I in 1914, Piłsudski led Polish forces on the side of Austria against Russia. The Russians were driven out of most of Poland by 1915. In the following year Austria and Germany established a small Polish kingdom under their protection. In 1917, Dmowski formed the Polish National Committee in Paris to win Allied support for an independent Poland. After the Allied victory in 1918, an independent Polish republic was proclaimed. Piłsudski became the first chief of state.

Under the 1919 Treaty of Versailles, which officially ended military actions against Germany, Poland regained large amounts of territory from Germany. The port of Gdańsk was made the Free City of Danzig under supervision of the League of Nations. The return of land in Pomerania, a region along the Baltic coast, gave Poland access to the sea. In the east, Poland tried to reestablish the boundary it had with Russia before partition. This led to a war with Russia in 1919 and 1920. The 1921 Treaty of Riga represented a compromise. It established a border that gave Poland some of its prepartition land.

Rebuilding the Polish nation. The new Polish state faced many problems. Its leaders had to unify three regions that had been separate for more than 100 years. About a third of its population consisted of minority groups, some of whom resented Polish rule. In addition, the partitions and World War I had disrupted the country's economy. During the 1920's and 1930's, Poland slowly rebuilt its economy and developed uniform systems of government, transportation, and education.

The 1921 Constitution of Poland provided for a democratic government. But many political parties competed

Important dates in Poland

A.D. 800's Slavic tribes in what is now Poland united under the Polanie.

1025 Boleslaw I was crowned the first king of Poland.

1386 The Jagiellonian dynasty was founded.

1500's The Polish empire reached the height of its power.

1772 Austria, Prussia, and Russia partitioned Poland.

1793 Prussia and Russia partitioned Poland.

1795 The third partition of Poland ended its existence as a separate state.

1918 Poland proclaimed itself an independent republic.

1939 Germany and the U.S.S.R. invaded and partitioned Poland.

1945 A Communist-dominated government was formed, and Poland's present-day boundaries were established.

1989 Poland held its freest election since the Communists took control. Non-Communist candidates received great support i[n] the elections.

1990 Poland's Communist Party was dissolved, and the country created a democratic system of government.

1997 A new constitution went into effect.

1999 Poland became a member of the North Atlantic Treaty Organization (NATO), a military alliance of Western nations.

r power, and the government was unstable. In 1926, lsudski led a military overthrow of the government. He en took control. In 1935, Poland adopted a new constition that confirmed many of Piłsudski's unrestricted owers and limited the development of democracy. Piłdski died in 1935. But his successors continued the olicy of semi-authoritarian rule.

In the 1930's, Poland began to be threatened by the owing military strength of Germany and the Union of oviet Socialist Republics (U.S.S.R.). The U.S.S.R., also alled the Soviet Union, had been formed in 1922 under ussia's leadership, and it existed until 1991.

In 1939, German dictator Adolf Hitler demanded that anzig (Gdańsk in Polish) be given to Germany. He also emanded transportation rights across eastern Pomeraa. The Poles resisted Hitler's demands and formed an liance with Britain. Britain and France, which had gned an alliance pact with Poland in 1921, pledged to efend Poland if the country's independence was directthreatened.

World War II. In August 1939, Germany and the Sovi Union signed a treaty in which they secretly planned divide Poland between themselves. On September 1, ermany attacked Poland. Britain and France then deared war on Germany. The U.S.S.R. invaded Poland on eptember 17. The Poles fought bravely, but were deated within a month. Germany and the U.S.S.R. then dided Poland. In 1941, Germany attacked the U.S.S.R. and eized all of Poland.

Shortly after the fall of Poland, a Polish government-exile was formed in Paris. Later, it was moved to Lonon. Polish armed forces joined Allied forces in many ampaigns. In addition, an underground Home Army perated inside Poland against the Germans.

After the German attack against the U.S.S.R. in 1941, olish Communists formed an exile center in the U.S.S.R. oles under the command of the U.S.S.R. fought against ermany on the eastern front. The Communists also rmed their own small underground movement. In 942, they established the Polish Communist Party. Władysław Gomułka became the party leader in 1943.

In 1944, the Soviet Union's army invaded Poland and egan to drive out the Germans. Also in 1944, the Home rmy staged an uprising against the Germans in Waraw. But after two months of fighting, the Home Army ad to surrender. That same year, a Polish Committee of National Liberation was formed in Lublin. The U.S.S.R. recognized the committee, which consisted almost entirely of Communists, as the provisional government of Poland. At the 1945 Yalta Conference, the Allies agreed to recognize the committee after it was expanded to include representatives of the London government-in-exile and other non-Communist groups.

Poland suffered widespread death and destruction during the war. Much of Warsaw and other cities were destroyed. Millions of Poles, including most Polish Jews, were put into concentration camps when the U.S.S.R. and Germany occupied Poland. Between 1939 and 1945, over 6 million Poles died. About half were Jews.

Agreements reached at the end of the war shifted Poland's borders westward, and millions of Poles were resettled. The U.S.S.R. kept most of eastern Poland. In return, Poland received the German lands east of the Oder and Neisse rivers, including major industrial regions.

Communist rule was opposed by most Poles. But the Communists used police power and other methods to crush resistance. Communist-controlled elections in 1947 gave them a large majority in the new legislature. By 1948, Communist rule was firmly established.

In the late 1940's, the U.S.S.R. gained increasing influence over the Polish government. In 1949, a Soviet military officer, Konstantin Rokossovsky, was made Poland's defense minister. Polish Communists suspected of disloyalty to the Soviet Union were removed from power. They included Władysław Gomułka, who, as first secretary, held the most powerful post in Poland. He was removed from his post in 1948 and imprisoned in 1951.

In 1952, Poland adopted a constitution patterned after that of the U.S.S.R. The constitution established the country as a *people's republic.* In theory, the working people of Poland held all political power. However, the Communist Party actually controlled the government. Only a few other small parties were allowed to exist, and they supported the Communist Party policies.

The government took control of the economy. The country's Communist leaders established a system of government-owned industries. They developed new industrial regions around Kraków, Warsaw, and other cities. Many people moved from the rural areas to take jobs in the cities.

The Communists forced farmers to give up their land and join collective farms that were managed by the gov-



he first partition, in 1772, resulted in oland's losing about a third of its land to e neighboring countries of Austria, russia, and Russia.



In the second partition, in 1793, Russia took most of the regions of Lithuania and Ukraine in eastern Poland. Prussia took most of western Poland.



WORLD BOOK maps

In the third partition, in 1795, Austria, Prussia, and Russia occupied what remained of Poland. Poland ceased to exist as an independent nation.

ernment. However, many farmers resisted, and the collectivization program ended in the 1950's.

The government placed restrictions on religious practices. As part of an antireligion campaign, the Communists imprisoned Stefan Cardinal Wyszyński, who was the head of the Roman Catholic Church in Poland.

Antigovernment protests. During the 1950's, many Poles began to express discontent with government policies and resentment of domination by the U.S.S.R. In 1956, workers in Poznań and other cities staged antigovernment riots. Władysław Gomułka was then freed from prison and again became head of the Communist Party. He ended the forced take-over of farmland and eased the campaign against religion. Cardinal Wyszyński was released from prison, and defense minister Rokossovsky was dismissed.

In the 1960's, Polish intellectuals protested against government limits on freedom of expression, and new disputes erupted between the government and the Catholic Church. In 1970, strikes and riots broke out in Gdańsk and other cities. Thousands of Poles demanded better living conditions and economic and political reforms. After days of riots, Gomułka resigned, and Edward Gierek became the Communist Party leader.

Gierek's leadership brought better relations between the government and the Catholic Church. Although Poland remained a loyal ally of the Soviet Union, its government took steps during the 1970's to improve relations with non-Communist countries.

In 1978, Karol Cardinal Wojtyła, a Polish cardinal and the archbishop of Kraków, was elected pope of the Roman Catholic Church. He took the name of John Paul II. He became the first Polish pope in history and the first non-Italian pope since 1523. He called on Poland's government to allow greater freedom to its people.

Poland struggled with high prices and shortages of food and consumer goods. In 1976, Poles rioted after the government announced big increases in food prices. Government leaders then deferred the increases. Economic conditions worsened in the late 1970's.

During the summer of 1980, thousands of workers in Gdańsk and other cities went on strike. They demanded higher pay, free trade unions, and political reforms. Communist leaders promised to meet many of the demands. In September, the Central Committee forced Gierek to resign and elected Stanisław Kania to replace him. In November, the Polish government recognized Solidarity, an organization of free trade unions. This wa the first time a Communist country recognized a labor organization that was independent of the Communist Party. Lech Wałęsa headed Solidarity.

Economic problems, including food shortages, increased. In October 1981, the Central Committee made Kania resign and elected Wojciech Jaruzelski, an army general, head of the Communist Party.

Jaruzelski's government faced continuing economic problems and demands by the people for economic im provements and greater political freedom. In Decembe 1981, Jaruzelski imposed martial law. He suspended Sol idarity's activities and had Wałęsa and hundreds of union leaders held as prisoners. In October 1982, the government officially outlawed Solidarity. Wałęsa and some Solidarity members were released in late 1982. The remaining prisoners were released over the next several years. Jaruzelski's government formally ended martial law in July 1983. But many controls over the peo ple's freedom were retained.

Free elections. In 1989, the government reached an agreement with Solidarity that led to the legalization of the union and to changes in the structure of the govern ment. Under the agreement, an office of president with broad powers was created, and a new legislature was formed. An upper house, the Senate, was added to the Sejm, the lower house, to form the National Assembly.

The elections that were held in 1989 were the freest i Poland since the end of World War II. Non-Communist candidates were allowed to compete for all Senate seat and some seats in the Sejm. The remaining seats in the Sejm were reserved for members and allies of the Com munist Party.

Solidarity candidates won all the lower-house seats they contested and all but one of the upper-house seats After the elections, parliament elected Jaruzelski president and appointed Tadeusz Mazowiecki, a Solidarity leader, as prime minister. Mazowiecki became Poland's first non-Communist prime minister since World War II The new government began to end Communist control over the lives of the people.

Also in 1989, the government began a program to sel government-owned industries to private owners. Much progress was made in this program in the 1990's. In 1990, Poland's Communist Party was dissolved.



In 1918, Poland became an independent republic. Later, Austria, Germany, Lithuania, and Russia gave up large amounts of territory to Poland.



In 1939, at the beginning of World War II, Germany and the U.S.S.R. divided Poland almost in half. Poland again disappeared from the face of Europe.



WORLD BOOK map

In 1945, at the end of World War II, a new Poland was formed. Most of the lan was retaken from Germany. The U.S.S.R. kept most of the land it had taken in 1939

In June 1990, Solidarity split into several groups. One oup supported Mazowiecki, and another supported ałęsa. In November, Mazowiecki, Wałęsa, and Stanisw Tymiński ran in a presidential election. Mazowiecki iished third and then resigned as prime minister. ałęsa won a runoff election against Tymiński in Dember and became Poland's president. After the elecɪn, Wałęsa resigned as head of Solidarity.

Parliamentary elections were held in October 1991. iis time, all seats in the legislature were contested. The 89 system of reserving seats in the lower house for embers of specific parties was abolished. The Democatic Union, a party that formed out of Mazowiecki's anch of Solidarity, won the most seats in both the ejm and the Senate. But it was not able to form a stable palition because of the large number of parties that id won parliamentary seats.

By 1993, economic hardship brought on by the iange to a free-market economy discouraged many eople. In 1993 elections, the Democratic Left Alliance id the Polish Peasant Party won the most seats in parment. Both parties included many former Commusts. The parties formed a coalition government and ipported more economic reform. In 1995, Aleksander vaśniewski, a former Communist leader, was elected esident in a narrow victory over Wałęsa. Kwaśniewski med to continue the reforms and to make Poland a irt of Europe's economic and security organizations.

Recent developments. In 1997 elections, Solidarity on the most seats in parliament and defeated theforer Communists who had been in control. Solidarity rmed a new coalition government with the Freedom nion. Also in 1997, the country's new constitution went to effect. In 1999, Poland became a member of the orth Atlantic Treaty Organization (NATO), a military alınce of Western nations. In 2000, Kwaśniewski was reected president. In parliamentary elections in 2001, the Democratic Left Alliance won the most seats. The party formed a coalition government with the Peasant Party.

Janusz Bugajski

© Filip Horvat, SABA

political rally held in the city of Gdynia during the 1989 elecıns showed support for candidates of Solidarity, an organizaın of free trade unions headed by Lech Wałęsa. The elections ere the freest elections held in Poland since the 1940's.

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VII. History

Questions

What is Poland's most important natural resource?
What is the Sejm?
Who was Poland's first non-Communist prime minister since World War II?
Where is Poland's major agricultural area?
How many Polish writers have won the Nobel Prize for literature?
What are Poland's chief seaports?
Who was the first Pole to become a pope of the Roman Catholic Church?
When did the first partition of Poland take place?

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Marvin E. Newman, DPI


Fred Baldwin, N.

The hardy polar bear lives along the frozen shores and in the icy waters of the Arctic Ocean. Polar bears have a thick, white coat that blends in with the ice and snow. They swim strongly by paddling with their front legs and stretching their head forward.

Polar bear is a large, white bear of the North. Most polar bears live in regions where the mass of sea ice surrounding the North Pole breaks apart during the summer. They live chiefly along the northern coasts of Canada, Greenland, and Russia, and on islands of the Arctic Ocean. Polar bears also are found near the northern coast of Alaska. Polar bears hunt seals and other animals for food.

Body. A polar bear has a long body, neck, and head; short, furry ears; and sharp teeth. Adult male polar bears measure from 8 to 11 feet (2.4 to 3.4 meters) long. Some of them weigh more than 1,000 pounds (454 kilograms). Most adult female polar bears are about 6 feet (1.8 meters) long and weigh 400 to 500 pounds (181 to 227 kilograms).

Polar bears have dense, white fur. Their fur and thick layers of fat beneath their skin protect them from the bitter cold. Their white fur also serves as camouflage when hunting.

Polar bears have a keen sense of smell. They can smell food as much as 10 miles (16 kilometers) away and can sniff out seal dens that are covered by thick layers of snow and ice. Polar bears are also good climbers and excellent swimmers. On land, they can run for short bursts at speeds of up to 35 miles (56.3 kilometers) an hour.

Habits. Polar bears feed mainly on a small species of seal called the ringed seal. In the spring, polar bears hunt young seals by killing them at their dens. Later, seals are hunted at holes in the ice where they come up for air. After the ice breaks up, polar bears may surprise


Jerry Cooke, Animals Anima

A mother polar bear guards her cubs. At birth, the cubs weig only about $1\frac{1}{2}$ pounds (0.68 kilogram) and are completely helpless. Most cubs live with their mother for the first 2 years.

ıls resting on floating ice by swimming up and poun- g on them. Polar bears also eat sea birds, lemmings, ı, berries, and grasses.

Polar bears live in dens during the colder months. A egnant female will usually occupy a den from October April. She most often digs the den in a deep snow- nk on the side of a hill or valley. In late November or rly December, she gives birth to her young—usually n cubs. At birth, polar bears measure only about 10 hes (25.4 centimeters) long and weigh about 1 $\frac{1}{2}$ unds (0.68 kilogram). Most family groups of polar ars stay together for about two years. Wild polar ars may live up to 33 years and those in captivity may a bit longer.

Polar bears and people. Although polar bears hunt er animals, they rarely kill people. But people threat- the survival of polar bears. Hunters have killed many lar bears for their pelts. Today, there are only about 000 wild polar bears in the world. The United States, nada, and other nations have laws that protect polar ars from hunters. C. R. Harington

Scientific classification. Polar bears belong to the family Ur- ae. They are *Ursus maritimus.*

See also **Bear.**

lar exploration. See **Antarctica** (Human activities); **ctic; Exploration** (Arctic exploration; The exploration Antarctica).

laris. See **North Star.**

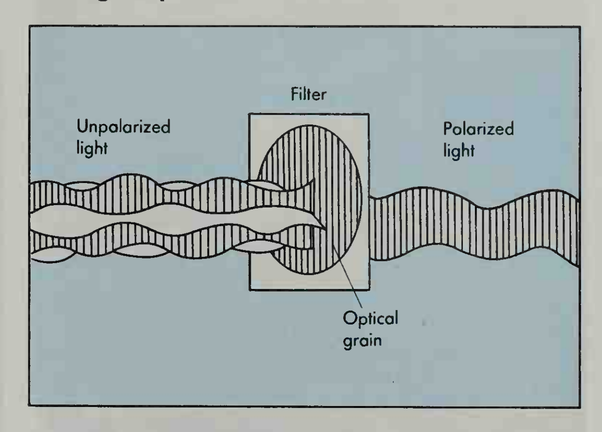
larization. See **Polarized light.**

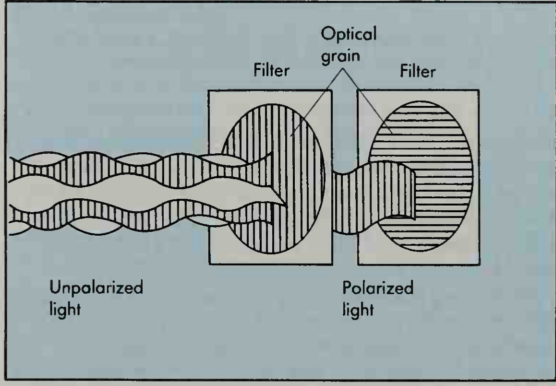
larized light consists of light waves that have a nple, orderly arrangement. The waves of ordinary ht are arranged in a complex, disorderly manner. Or- nary light from the sun or a lamp is composed of dis- derly waves that vibrate in *all* directions perpendicu- to the light beam. But polarized light consists of derly waves that vibrate in only *one* direction. Because its orderly structure, polarized light can be used in ys in which ordinary light cannot. For example, the in- nal physical structure of many transparent materials be seen with the aid of polarized light. Light polariz- are powerful tools that are used in science, industry, d daily life.

How light is polarized. To understand polarization, nk of a light beam as a train of electromagnetic waves. e electromagnetic forces making up these waves vi- ate in a direction perpendicular to the path of the am. A rough example of these waves can be made by aching a rope to a wall and shaking the other end. A in of waves will move along the length of the rope. ch part of the rope will vibrate in all directions per- ndicular to its length. Waves that vibrate in this way called *transverse waves.* See **Waves** (Transverse ves; illustration).

Polarized light vibrates in a single direction perpen- ular to its path. Ordinary light can be polarized by ssing it through a special *light polarizing filter.* This fil- allows only the waves that vibrate in one perpendic- r direction to pass through. The structure of the light larizing filter prevents the passage of light waves that rate in other perpendicular directions. In scientific ms, the light polarizing filter allows the *components* rts) of the light waves that vibrate in one *vibration-di- tion* to pass through. The components of waves that rate in all other directions are held back. The light

How light is polarized





WORLD BOOK diagrams by Arthur Grebetz

Unpolarized light consists of waves that vibrate in all directions perpendicular to its path. A light polarizing filter allows only those waves that vibrate in a direction parallel to its optical grain to pass through, *top.* When the optical grain of a second filter is set at 90° to the grain of the first, the polarized light from the first filter is completely absorbed by the second, *bottom.*

that passes through the light polarizing filter is called *polarized light.*

All the vibrations that pass through a polarizing filter vibrate in one direction—a direction parallel to the opti- cal grain of the filter. The *optical grain* is the transmis- sion axis of the filter. Polarized light can pass completely through a second polarizing filter whose transmission axis is parallel to that of the first polarizing filter. But if the second polarizer is rotated like a wheel, it will grad- ually dim the light that comes through it. The second po- larizer will cut off the light entirely when its axis is "crossed" at 90° to the axis of the first polarizing filter. The dimming and cutting off occur because each polar- izing filter absorbs all components of the light that do not vibrate parallel to the filter's axis. As a result, the brightness of the light beam is gradually reduced as the transmission axis of the second polarizer cuts across the transmission axis of the first.

Many applications of polarized light are based on this phenomenon. For example, much of the light around us is already polarized. Mirrorlike reflections from shiny horizontal surfaces, such as pavement and water, con- sist largely of light that has been horizontally polarized



WORLD BOOK photo by Dan Miller

Without a polarizing filter, a photograph looks like a double exposure because the camera picks up reflections.



WORLD BOOK photo by Dan M

With a polarizing filter, a photograph is clear because the fi placed over the camera lens absorbs the reflections.

in the process of reflection. Polarized sunglasses, with their transmission axis set vertically, block the horizontally polarized light making up the bright reflections. Photographers use polarizing filters to cut down glare and reflections from shiny surfaces such as windows and water.

Polarizing materials. The most widely used light polarizers consist of thin plastic sheets. A typical plastic sheet contains millions of long, slender, carefully aligned chains of iodine molecules. Each of these chains acts like an individual polarizing filter. Sheet polarizers have greatly extended the uses of polarized light because of their low cost and convenient size. Edwin H. Land, inventor of the Polaroid Land camera, invented the first sheet polarizer in 1928, when he was 19 years old.

Some natural crystals, such as *tourmaline,* can polarize light. Tourmaline transmits the components that lie in one vibration-direction, and holds back others by absorbing them internally. Another natural polarizing crystal is *calcite,* or *Iceland spar.* It divides the light into two polarized beams that are at right angles to each other. *Nicol* prisms are cut from Iceland spar so that one of these beams is eliminated.

Uses of polarized light. Scientists have suggested that polarized glass be used for car headlights and windshields to prevent driving glare from the lights of approaching cars.

Scientists can study the structure of many transparent materials with the aid of crossed polarizing filters. Microscopes equipped with polarizers show many colorless crystals and biology specimens in brilliant color. A *polariscope,* an instrument equipped with polarizers, is used to find *strains* (weak spots) in glass objects such as eyeglasses and laboratory glassware. Chemists can tell the type and amount of sugar in a solution by using a *saccharimeter,* a type of polariscope. Special polarizing filters that produce circularly polarized light are used on radarscopes to trap unwanted reflections.

Brian J. Thompson

See also **Land, Edwin Herbert; Light** (How light behaves [Polarization]); **Tourmaline.**

Polder. See **Netherlands** (introduction; The land; pic ture); **Belgium** (The land [Coastal and interior lowland

Pole. The earth is constantly *rotating* (spinning) on an imaginary line called an *axis.* The axis passes through t center of the earth and ends at either *pole.* The north end of the axis is the North Pole, 90 degrees north of t equator. The South Pole is the south end of the axis, 9 degrees south of the equator.

The term *pole* may be used to describe such a poin on any revolving sphere. For example, *celestial pole* refers to a point in the heavens around which the stars seem to revolve. A bright star located nearest to the ce lestial pole is called the *North Star,* or sometimes *polestar.*

In addition to the north and south geographic poles the earth has north and south magnetic poles, the farthest points on the earth in the directions of magnetic north and south. The north magnetic pole is currently cated near Ellef Ringnes Island in northern Canada, which is about 870 miles (1,400 kilometers) from the north geographic pole. The south magnetic pole is off the coast of Antarctica, which is about 1,710 miles (2,75 kilometers) from the south geographic pole.

In physics, the word *pole* means the point where magnetic lines of force appear to originate. Magnetic poles that are unlike attract one another, and like magnetic poles repel each other. Stephen S. Birdsall

See also **Earth** (Earth's size and shape); **Magnetism** (The magnetism of the earth); **North Pole; North Star; South Pole.**

Pole vault is an event in track and field competition i which athletes use a pole to propel their body over a crossbar set at a certain height. The equipment neede for pole-vaulting includes the pole, a crossbar, and tw upright standards to support the crossbar. The pole ca be made of any material. However, all good vaulters u poles made of fiberglass. The pole is from 12 to 17 $\frac{1}{2}$ fe (3.7 to 5.3 meters) in length. The fundamentals of pole-vaulting include (1) the grip, (2) the run, (3) the plant an take-off, (4) the swing, (5) the pull-up, and (6) clearing th bar.

The grip is important in pole-vaulting. The athlete ust position the hands properly and place them at the eal height on the pole. He or she places one hand 2 to feet (61 to 91 centimeters) below the other hand, and olds the pole parallel to the ground.

The run down the runway toward the crossbar is ade almost at top speed, but the vaulter controls the n carefully. Markers along the runway allow the ulter to gauge his or her stride and take-off position that the take-off is from the same foot and at the same ace in every vault. During the run, the vaulter keeps s or her eye fixed on the box that is set in the ground eneath the crossbar.

The plant and take-off. The vaulter *plants* (places) e end of the pole in the box. As the speed obtained own the runway is transformed into upward motion, e pole bends. As it straightens, it helps the vaulter rust upward.

The swing and pull-up. As the vaulter holds onto e rising pole and swings the body through the air, he she pulls the knees up toward the chest and then oots the feet up toward the bar. The swing and ll-up produce a handstand effect with the vaulter's est next to the crossbar.

Clearing the bar. While the vaulter is in the hand-and position, the feet start down on the other side of e crossbar. This position of the body is essential for aximum height. The vaulter then pushes the pole away it will not hit the crossbar and knock it down. As the ulter releases the pole, he or she turns the thumbs in-ard to help prevent the elbows from hitting the cross-r. Michael Takaha

For world championship figures in the pole vault, see e *tables* with the articles **Track and field** and **Olympic ames.**

olecat is a small mammal that belongs to the weasel mily. There are three species of polecats: (1) the Euro-ean polecat, found throughout Europe, (2) the steppe olecat, found in the plains of central Asia, and (3) the arbled polecat, found in the dry grasslands of southeastern Europe to western China. The North American skunks are often called polecats because their habits are similar to those of the European polecat.

Polecats prey mainly on mice, rats, and other rodents. They also feed on birds, eggs, rabbits, fish, reptiles, insects, amphibians, and fruit. Polecats are active mostly at night and rely on their sense of smell to locate food. They usually live in an underground burrow, which has a special section to store extra food.

Polecats live alone, except during the mating season or when the female is raising her young. Five to eight young are born about 40 days after mating. They leave their mother after three months. When frightened, polecats discharge a strong-smelling fluid from scent glands under the tail. A polecat also uses this fluid to mark its *territory*, the area it will defend against intrusion from other polecats.

A polecat has a long, slender body and short legs, which enable it to chase rodents in burrows. All three species have a "mask" of darker hair around their eyes. European polecats have dark outer fur, with lighter colored underfur showing through. Their fur is marketed under the name *fitch*. Male European polecats are 13 to 18 inches (33 to 46 centimeters) long, not including a tail of 4 to 7 inches (11 to 18 centimeters). As with all polecat species, females are smaller.

Steppe polecats are usually brown or yellowish, with a dark tail and legs. Males measure 14 to 22 inches (35 to 56 centimeters) long, not including a tail of 3 to 7 inches (8 to 18 centimeters). Marbled polecats have a reddish-brown back, with patches of white or yellow. Male marbled polecats are 11 to 15 inches (28 to 38 centimeters) long, with a tail that measures 6 to 9 inches (15 to 22 centimeters).

Scientific classification. Polecats belong to the family Mustelidae. The scientific name for the European polecat is *Mustela putorius*. The steppe polecat is *M. eversmanni*, and the marbled polecat is *Vormela peregusna*.

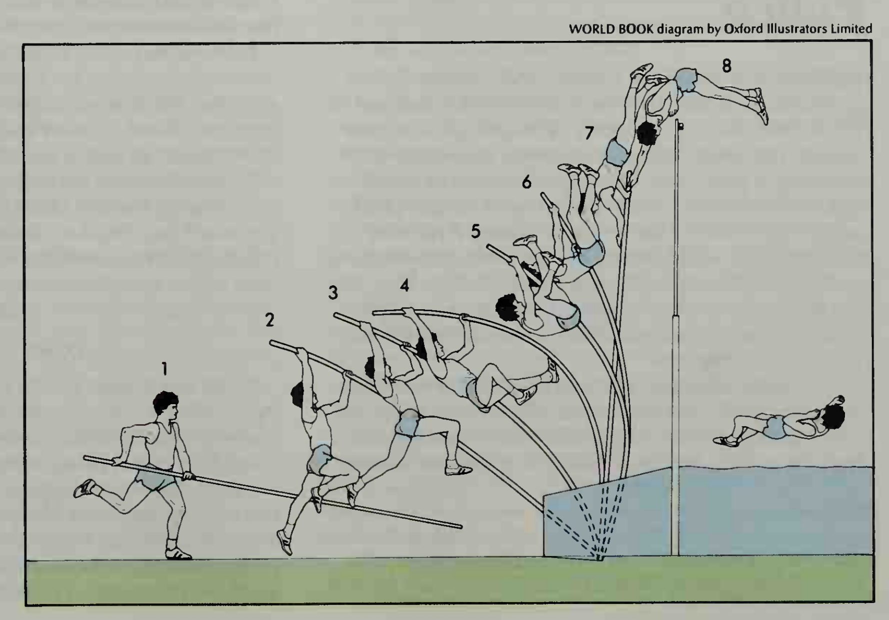
Barbara L. Clauson and Robert M. Timm

Polestar. See North Star.

WORLD BOOK diagram by Oxford Illustrators Limited

ole-vaulting technique

ole-vaulting requires coordi-tion, strength, and timing. e diagram on the right ows the basic steps in pole-ulting. (1) the vaulter sprints own the runway. (2 and 3) He aces the end of the pole in e take-off box, bending the ole. (4 and 5) As the pole raightens, it provides the ower to swing the vaulter up ward the bar. (6, 7, and 8) At e top of his jump, the ulter twists his body to ear the bar.





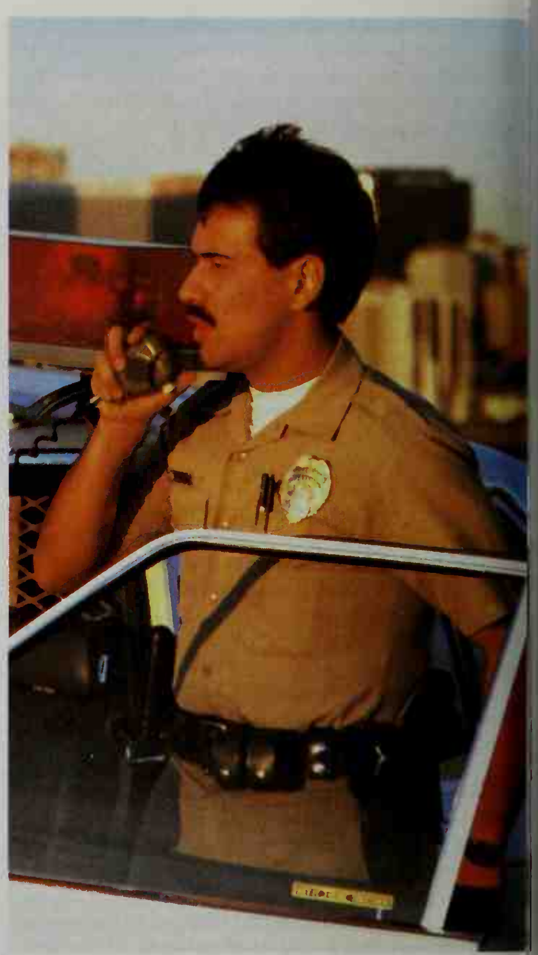
Audio Visual Unit, Philadelphia Police Department

Officers on foot patrol



WORLD BOOK photo by Ralph Brunke

Police department communications center



Bart Bartholomew, Black

Patrol officer in squad car

Police

Police are government officers who enforce the law and maintain order. They work to prevent crime and to protect the lives and property of the people of a community. Policemen and policewomen serve their communities in many ways. They patrol streets to guard against crime and to assist people with various problems. Police officers direct traffic to keep it running smoothly and safely. The police are often called to settle quarrels, find lost people, and aid accident victims. During floods, fires, terrorist attacks, and other emergencies, they help provide assistance, transportation, and protection for victims.

The police form part of a nation's *criminal justice system,* which also includes courts and prisons. Police officers enforce *criminal law,* which covers murder, robbery, terrorism, and other crimes that threaten society. Police officers investigate such crimes and arrest suspected lawbreakers. They also testify in court trials.

Every nation in the world has a police system. In the United States, there are about 40,000 separate police agencies that operate under city, county, state, or fede al governments. In many countries, the national gover ment directs all police operations.

Police officers in the United States are often called *cops.* During the late 1800's, they were called *constab* The word cop may have come from the initials *c. o. p.,* which stood for *constable on patrol.* Some experts believe *cop* is short for *copper,* a word that referred to t copper badges worn by police officers.

George T. Felkenes, the contributor of this article, is Professor Emeritus of Criminal Justice at Claremont Graduate University and author of The Criminal Justice System.

Police activities

Patrol operations are the foundation of police work. Patrol officers are assigned *beats* (areas or routes) to cover on foot, in squad cars, or on motorcycles. In so cities, they patrol parks on horseback.

Patrol officers survey their beats repeatedly. Foot pa trol officers carry two-way pocket radios, and patrol c are equipped with larger two-way radios. Officers ma receive assignments over their radios to handle an au accident, investigate a reported crime, or settle a fami



© Andy Levin

omb squad technician



Audio Visual Unit, Philadelphia Police Department

pecial weapons unit

argument. If necessary, they may call the police sta- on for assistance in handling an assignment. Patrol offi- ers are often assigned to control crowds at parades, irs, and other public events.

Police officers may arrest a person they see commit- ng a crime. They also may arrest a person if they have easonable cause to suspect that the person is commit- ng a crime or is about to commit one. But in some cas- s, police officers are required to get a court order alled a *warrant* before making an arrest.

Traffic operations. Traffic officers promote public afety on streets and highways. They direct traffic; pro- ect pedestrians; aid motorists; and enforce parking, peed, and other traffic laws. Traffic officers also investi- ate traffic accidents and enforce safety and license reg- lations for motor vehicles. Some police departments se helicopters to survey traffic.

Investigations of crimes are conducted by detec- ves, who are sometimes called *plainclothes officers* be- ause they do not wear uniforms. In some police depart- ients, the term *plainclothes officers* refers to members f the *vice squad.* The vice squad investigates cases that ivolve gambling, prostitution, or other illegal activities onsidered to be immoral.

Detectives work in various specialized fields that deal with such crimes as murder, robbery, or the illegal sale of drugs. In a murder case, detectives may start their investigation by searching for bloodstains, fingerprints, and weapons. They question any witnesses, suspects, or others who may have information about the crime.

Various technical units in a police department assist the detectives in an investigation. The *photography unit* takes pictures of the crime scene and the evidence. The *crime laboratory* collects and examines bloodstains,bullets, hair samples, fingerprints, weapons, and other evidence. Experts in the laboratory may perform chemical tests to identify any unknown substance connected with the crime. The detectives in charge of an investigation supervise the technical units involved. Later, the reports of the detectives and the technical units are used in court.

Criminal intelligence. Some police officers are assigned to gather *intelligence* (information) about the activities of suspected criminals. The women and men who work in the criminal intelligence division of a police department are sometimes called *undercover agents.* They gather information on such criminal operations as large-scale gambling, the illegal sale of drugs, and terrorist activity. The reports of intelligence officers are used in planning ways to fight criminal activities.

Juvenile work. Officers in the juvenile division of a police department handle cases involving youths accused of breaking the law. In most states of the United States, anyone under the age of 18 is considered a juvenile. Juvenile officers often refer young people to social agencies rather than bring criminal charges against them in a court. These officers try to help the young people and their parents with personal problems. They also investigate crimes that involve neglect or abuse of young children. The officers may testify in court to protect the rights of the youngsters. Also, juvenile officers often work with young people in community programs.

Records and communications. The records bureau of a police department keeps files on all reported crimes, investigations, and arrests, and on various police activities. Many police departments use computers to process and store these records.

The communications center is another important unit of a police department. Its *central dispatch office* receives calls for help or reports of crimes and sends officers to the scene. Many larger police agencies use computers in this operation. When a report of a crime or a call for help comes into the central dispatch office, the information is typed on the *terminal* of a computer. A terminal is an electronic keyboard that can both receive and send information. A dispatch officer reviews the problem and sends the information to one or more available patrol cars. The patrol officers receive the assignment over terminals in their cars.

Other activities. Large police agencies have various specialized units, including *search-and-rescue teams, hostage negotiating teams, bomb squads,* and *special weapons units.* Most members of such units work at other assignments until their special skills are needed. Some medium-sized and large police departments also have *data processing and research offices.*

Search-and-rescue teams try to find persons lost in forests, mountains, caves, or other out-of-the-way

places. Members of these teams are trained in rock climbing, mountain survival, and other skills. They often use helicopters and airplanes in rescue missions.

Hostage-negotiating teams handle cases in which criminals hold people captive. During some crimes, including bank robberies and airplane hijackings, the criminals may take innocent people as hostages. They threaten to injure or kill the hostages if certain demands are not met. Members of the hostage-negotiating team try to persuade the criminals to release the hostages without harm. Team members are skilled in psychology and personal relations.

Bomb squads respond to reports of bomb threats. They search the building or other place where a bomb supposedly has been planted. If they find a bomb, they try to prevent it from exploding or move it to a place where it cannot damage property or injure people.

Special weapons units handle dangerous situations involving armed criminals. Members of these units are skilled in the use of high-powered rifles and other weapons. They know how to surround and capture criminals with the least possible danger to others. Special weapons units are often called *S.W.A.T.* teams. Those letters stand for *S*pecial *W*eapons and *T*actics or *S*pecial *W*eapons *A*ttack *T*eam.

Data processing and research offices perform a variety of services. These offices may be staffed by police officers or by private citizens. Staff members compile crime statistics to help identify high-crime areas. They also prepare reports on personnel needs. In addition, they research new investigation techniques.

Computer crime specialists fight crimes committed with computers. Such crimes include embezzlement by bank employees and others with access to their employers' computer systems. Computer crime experts also may work to prevent fraud and other criminal activities on the global computer network known as the Internet.

Police in the United States

In the United States, police agencies operate under the city, county, state, and federal governments. Each agency is responsible only to its own division of government. Private police agencies are licensed by the states to provide certain types of police services.

City police. The size of a city police force depends on the size and needs of the community. New York City has the largest city police department in the United States—about 29,000 police officers. A small town may have a police force of only one or two officers.

City police are mainly responsible for enforcing the law in their own city. In some states, city police may exercise police powers in other communities only under special circumstances. In other states, city police may exercise police powers throughout the state. A few communities have combined their city and county police forces into a single *metropolitan police* force.

Some city police departments have specialized forces with certain limited powers. Such forces include airport police, housing police, park police, and transit police.

In most cities, the mayor appoints the head of the police department. This official may have the title of *chief, commissioner, director,* or *superintendent.* Other ranking police officers include *inspectors, lieutenant colonels, majors, captains, lieutenants,* and *sergeants.*

County police. The powers of a county police forc extend throughout the county. In some states, howeve these powers are restricted in towns and cities that ha their own force. A *sheriff,* elected by the people, is the chief law enforcement officer in most counties. In som states, the sheriff's department provides police service on a contract basis to cities and towns within the coun

The duties and powers of the sheriff's department vary from county to county. In some counties, the sher takes charge of prisoners in the county jails, attends se sions of the county court, and carries out court rulings in matters of *civil law.* Civil law covers such matters as business disputes and the transfer of property. In othe counties, the sheriff's department may also conduct fu scale police operations and provide training and techn cal services to city police.

State police. Every state but Hawaii has either a stat police force or a state highway patrol force. The powe of these forces vary from state to state. A commissione or superintendent chosen by the governor heads both types of agencies. Hawaii has only county police force:

State police enforce state laws. They also may coord nate police activities within the state and provide techr cal services and training programs to city and county police departments. State police officers are sometime called *troopers* because they were originally organize along military lines and often rode horses. Most state highway patrol forces have the primary duty of enforcing highway and motor vehicle regulations. Some also conduct full-scale police operations.

Federal law enforcement agencies include the Federal Bureau of Investigation (FBI). The FBI is the chi investigating branch of the U.S. Department of Justice. investigates federal crimes and handles cases involvin stolen money or property that has been taken across state borders. The FBI also operates the National Crim Information Center (NCIC) in Washington, D.C. The NC is a computerized information system that stores records on wanted persons and stolen property. Police de partments in every state are linked to the NCIC throug local terminals and may obtain information at any time

Nine other major federal law enforcement agencies also have full police powers. They are the Bureau of Al cohol, Tobacco, and Firearms; the Drug Enforcement Administration; the Immigration and Naturalization Se ice; the Internal Revenue Service; the Postal Inspectio Service; the U.S. Coast Guard; the U.S. Customs Servic the U.S. Marshals Service; and the U.S. Secret Service.

The Department of Justice also includes the Bureau Justice Statistics and the National Institute of Justice. These offices do not enforce laws, but they support po lice programs that aim to prevent and control crime. They do this mainly through research and analysis of various aspects of crime and the criminal justice syste

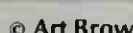
Private police agencies are licensed by the states perform limited types of police work. *Industrial securi police* guard factories and warehouses. *Campus polic* protect the people and property of colleges and unive sities. *Private investigative agencies* provide detective services to individuals and businesses.

Police around the world

In many countries, the national government directs the police system and maintains a national police forc

olice around the world





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ina



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France



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Ghana



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Mexico

In Canada. Canada has national, provincial, and city olice forces. The Royal Canadian Mounted Police CMP) enforces federal laws throughout Canada. It rves as a provincial police force in all provinces ex- pt Ontario and Quebec, which have their own forces. ie RCMP is the only police force in the Yukon Territory id the Northwest Territories. The RCMP provides po- e services on a contract basis to about 175 cities.

Members of the RCMP are traditionally called iounties," though they now ride horses only in special eremonies. For their daily assignments, they travel in rs, snowmobiles, helicopters, and other vehicles. See oyal Canadian Mounted Police.

In other countries. In the United Kingdom, the po- e system is organized into about 50 large forces that e connected with local governments. These forces operate under the direction of the national government. The London Metropolitan Police serve Greater London except for an area that is called the City of London, which has its own force. The headquarters of the Metropolitan Police is called New Scotland Yard. The name *Scotland Yard* is often used to refer to the Criminal Investigation Department of the Metropolitan Police (see **Scotland Yard**).



Royal Canadian Mounted Police

ie Royal Canadian Mounted Police enforces federal laws oughout Canada. This officer is checking the driver's license a motorist she has stopped for a traffic violation.

In Australia, each of the six states and two mainland territories has a police force. Australia also has a national police force, the Commonwealth Police Force.

In France, the national law enforcement agency is the Sûreté Nationale. The Sûreté Nationale forms part of the Ministry of the Interior. Police officers called *gendarmes* serve as military police and provide police services in rural areas.

In Germany, the police are organized under the individual states. The states also maintain stand-by police who assist the state police when necessary.

In Russia, the Ministry of Internal Affairs (MVD) is in charge of providing general police services. It also provides border guards and investigates activities considered a threat to the security of the national government.

In China, a national police force called the People's Police is directed locally by provincial public security bureaus. These bureaus function under the Ministry of Public Security, an agency of the national government.

Interpol is an international organization of police forces from almost all countries. Its official name is the *Inter*national Criminal *Pol*ice Organization. Members of Interpol exchange information about international criminals and cooperate in fighting such international crimes as counterfeiting, smuggling, and illegal buying and selling of weapons. The headquarters of Interpol are in the city of Lyon in France.

History

In many ancient societies, the military forces served as police. In ancient Rome, for example, the military



Photoworld, FPG

Bobbies stand guard outside a royal wedding in London in 1923. British police were nicknamed *bobbies* after Sir Robert Peel, who founded the first modern type of police force in 1829.

legions of the rulers enforced the law. Augustus, who became emperor in 27 B.C., formed a nonmilitary police force called the *vigiles.* The vigiles were responsible for keeping the peace and fighting fires in Rome.

Early law enforcement in England. During the A.D. 800's, England developed a system of law enforcement based on citizen responsibility. The people of a community were divided into *tithings* (groups of 10 families), and each tithing was responsible for the conduct of its members. Males more than 16 years old stood watch duty. When a serious crime occurred, all able-bodied men joined in a *hue and cry* (chase of the suspect). Each *shire* (county) was headed by a *reeve* (chief). The word *sheriff* is a shortened form of *shire reeve.*

In 1750, Henry Fielding, a London *magistrate* (judge) and author, organized a group of law enforcement officers called the Bow Street Runners. These officers ran to the scene of a crime to capture the criminal and begin an investigation.

Sir Robert Peel, a British statesman, founded the London Metropolitan Police in 1829. The force was established along military lines, and its officers were carefully selected and trained. The public called the officers *bobbies,* after Sir Robert, and they still have that nickname. Peel is regarded as the father of modern police organizations.

Law and order in America. The American colonists established the English watch system in the towns and villages of New England. In many colonial areas, sheriffs and constables were responsible for keeping the peace.

Later, on the Western frontier, sheriffs and marshals enforced the law. But citizens sometimes formed groups of self-appointed law officers called *vigilantes* to capture and punish outlaws (see **Vigilante**). The Texas Rangers, band of mounted riflemen organized in the early 1800's were the first form of state police. They fought Indians, patrolled the Mexican border, and tracked down cattle rustlers and other outlaws. In 1905, Pennsylvania established the first state police force.

In 1845, New York City combined its separate day an night watches into a single city police force modeled a ter the London Metropolitan Police. Other U.S. cities formed similar police forces during the following year

Many early city police departments were poorly organized. Officers were underpaid and got little training In many communities, city leaders gained control of th police. They used the police in conducting their politic campaigns and for other personal purposes.

During the early 1900's, August Vollmer, the police chief of Berkeley, California, gained fame as a police re former. Vollmer brought about many changes in the po lice system. He urged reorganization of police departments, college education for police officers, and the us of scientific methods in police work.

Today, most medium-sized and large police departments hire officers through the civil service process (se **Civil service**). In this way, officers are not subject to po litical influence.

In the United States since the mid-1900's, riots ha broken out from time to time in a number of cities. In some of these uprisings, especially in the 1960's and 1970's, African Americans rioted in anger at their poor living conditions and few job opportunities. In other ca es, the rioters were college students who opposed var ous policies of the government or of their schools. In trying to control the rioters, the police were sometime charged with using unnecessary force. In later years, a number of riots were triggered by incidents in which the police were believed to have used excessive force dealing with individual members of minority groups. A a result of these events, hostility toward police officers sometimes has became widespread, especially among minorities. These groups have accused the police of treating them unfairly and giving them poor protection in their neighborhoods.

In an effort to improve their relations with citizens a to reduce crime, some police departments have devel oped or expanded community relations and crime pre vention programs. Police officers meet with neighborhood residents and civic organizations to discuss problems and explain police services. Neighborhood police teams have been established to bring the police into closer contact with neighborhood residents. Thes teams of police officers patrol specific neighborhoods and investigate all crimes there. In some areas, special juvenile gang units focus on preventing gang member ship, identifying gang members, and stopping illegal gang activities.

The police also encourage citizens to help fight crim In some communities, citizen volunteers organize patrols to guard housing projects and homes. Other com munities organize Neighborhood Watch programs in which residents report any suspicious activities in thei neighborhood to the police. Many police departments have employed more nonpolice personnel to handle such police duties as traffic control and dispatching. Th use of these employees has enabled the departments

sign more police officers to the fight against crime.

Since 1970, the number of women entering police ork has increased substantially. Also, police depart- ents now assign female officers to patrol duty and ime investigation. Formerly, female police officers rved chiefly as office workers, as juvenile officers, and guards in women's prisons. Police agencies also have ade more of an effort to hire more members of minor- groups as police officers.

Investigations of several city police departments since 70 have revealed cases of police corruption. Some of- ers have been found guilty of taking bribes and com- itting other crimes. As a result of these investigations, lice leaders have stressed the need to maintain high andards in hiring recruits, to provide the best possible ining for officers, and to promote professional in- grity throughout the police department.

Careers

Police work offers many opportunities to help people d to serve a community. However, it can be danger- s and sometimes requires working irregular hours.

The requirements for applicants for positions with po- e agencies vary among the cities and states. The mini- um age requirement for police work varies from 18 to . Some police agencies have a maximum entry-level e of 35. Candidates must pass a thorough physical ex- nination, be honest and even-tempered, and have od judgment and a sense of responsibility. Most po- e agencies require that candidates obtain a high hool education, and many require some college train- g. Applicants must pass a written examination. Some lice agencies require officers to live and work in the me community.

Recruits attend police academies connected with the ty, county, or state police agencies. Training periods ry from 6 weeks to a year. Recruits study such subjects law, psychology, sociology, traffic control, weapons, d rules of evidence. Many police agencies also re- ire recruits to spend a period with a field training offi- r in a squad car before going on duty alone.

Numerous police agencies have continuing education ograms to keep officers informed of changes in the w and new techniques in police work. Some agencies fer the benefit of paying the cost of a college educa- n for officers who wish to acquire this schooling.

George T. Felkenes

Related articles in *World Book* include:

Biographies

rrett, Pat
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Kinds of police

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Federal law enforcement agencies

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rder Patrol, United States
ast Guard, United States
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Secret Service, United States

Other related articles

Armor (picture: Police officers use armor)
Arrest
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Clothing (pictures)
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Miranda v. Arizona
Police dog
Police state
Radar (In controlling automobile speed and traffic)
Riot (Expressive riots)
Search warrant
Thermography
Warrant
Western frontier life in America (Law and order)
Wiretapping

Outline

I. Police activities
- A. Patrol operations
- B. Traffic operations
- C. Investigations of crimes
- D. Criminal intelligence
- E. Juvenile work
- F. Records and communications
- G. Other activities

II. Police in the United States
- A. City police
- B. County police
- C. State police
- D. Federal law enforcement
- E. Private police agencies

III. Police around the world
- A. In Canada
- B. In other countries
- C. Interpol

IV. History

V. Careers

Questions

How is the police system in the United States organized?
What are the duties of patrol officers? Traffic officers?
How do citizen volunteers help the police prevent crime?
What does the Royal Canadian Mounted Police do?
How do photography units, ballistics squads, and crime laboratories assist detectives?
What is Interpol?
Why are London Metropolitan Police officers called *bobbies*?
What is the National Crime Information Center?
Who was August Vollmer? How did he help reform police departments in the United States?
What are S.W.A.T. teams?

Additional resources

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Police dog is the common but incorrect name for the German shepherd dog. This name is not correct because many other breeds of dogs, such as the Airedale terrier and Doberman pinscher, receive special training to help the police. Such dogs receive special training in tracking down criminals, in guard duty, and in other types of work. See also **German shepherd dog.**

Police state is any nation or other political unit in which the government allows its law enforcement agencies to maintain order through terror. In such a state, the police are not subject to laws or other restraints that would ordinarily limit their actions in a constitutional democracy. The police can spy on anyone without regard for privacy. They can also arrest, imprison, execute, or exile people for any reason.

In ancient times, the Greek city-state of Sparta had the most developed form of police state. During the 1900's, fascist and Communist countries often used police state tactics. Alexander J. Groth

See also **Secret police.**

Polio. See **Poliomyelitis.**

Poliomyelitis, *POH lee oh MY uh LY tihs,* also called *polio* or *infantile paralysis,* is a serious infection caused by a virus. In the past, epidemics of polio were common and were greatly feared because the disease left many patients paralyzed for life. In the 1950's, however, a vaccine against the disease was introduced. Since then, polio has been nearly eliminated in developed countries.

Kinds of poliomyelitis. A polio virus may attack the nerve cells of the brain and spinal cord, causing paralysis. However, infection by a polio virus does not always result in severe illness. Some patients show only mild symptoms, such as fever, headache, sore throat, and vomiting. Symptoms may disappear after about a day.

Severe polio attacks begin with the same symptoms as the mild attacks. The symptoms, however, do not di appear. Stiffness of the neck and back develops. The muscles become weak, and movement is difficult. Pain may occur in the back and legs, especially when these parts are stretched or straightened. If paralysis develo the person may not be able to stand or walk.

Most people who develop polio do not become pe manently paralyzed. Paralysis can occur in many degrees and combinations. *Spinal poliomyelitis* is probal the most common form of polio. It occurs when polio viruses attack the nerve cells that control the muscles the legs, arms, trunk, diaphragm, abdomen, and pelvis *Bulbar paralysis* is the most serious form of the diseas It results from damage to the nerve cells of the brain stem. Some of these nerves control the muscles for swallowing and for moving the eyes, tongue, face, anc neck. The nerves that control breathing and the circula tion of body fluids may also be affected.

Some polio patients suffer new symptoms about 30 years or more after the initial attack. These symptoms clude fatigue, muscle weakness, pain in the joints, and difficulty in breathing. Physicians are not sure what ca es this condition, called *post-polio syndrome.*

Cause of poliomyelitis. There are three viruses tha cause polio. They are called types I, II, and III.

Polio viruses can grow only in living cells. They get into the body through the nose and mouth and are ca ried to the intestines. Then they travel along the nerve fibers or are carried by the blood to the central nervo system. There, they enter a nerve cell and multiply so rapidly that they damage or kill the cell. Paralysis resul when many cells are destroyed. Scientists do not kno why epidemics occur. People who become infected b the virus do not always get polio. The virus has been found in apparently healthy people, especially during epidemics.

Prevention of poliomyelitis. There are two polio vaccines, and both protect against all three types of po lio viruses. The first vaccine, developed by the Americ researcher Jonas E. Salk, is given by means of injectior It was declared safe and effective in 1955. The other po lio vaccine was developed by Albert B. Sabin, another American researcher. It was approved for use in the United States in 1961. The Sabin vaccine is an *oral vaccine*—that is, it can be taken by mouth.

Children should be vaccinated against polio early in life. A vaccine is typically given in four doses—at 2 months of age, 4 months, 15 months, and 4 to 6 years age. The United States Centers for Disease Control an Prevention recommends two doses of injectable vacci followed by two doses of the oral form. When used fo all four doses, the oral form can, in extremely rare cas cause paralytic polio. However, the agency also consid ers four doses of either vaccine alone acceptable.

Treatment of poliomyelitis. No drug has yet been found that can kill the polio virus or control its spread the body. But the degree of recovery often depends o immediate medical attention and good nursing care.

Complete rest in bed is perhaps the most importan treatment. Doctors believe that fatigue may make the disease more severe. They use simple treatments, suc as hot, moist bandages, to relieve pain. After the fever



March of Dimes Birth Defects Foundation

Polio was one of the most feared diseases until an effective vaccine was found in 1955. This photo from the 1950's shows a polio patient learning to walk with crutches and leg braces.

es down, physical therapists may gently move the patnt's limbs to prevent deformities and painful tighteni of the muscles. Later, more intensive exercises help sengthen and retrain the muscles. Even extensively palyzed patients can often develop enough movement tarry on many activities. Less severely paralyzed peop usually resume most of their previous activities. Sne may need splints, braces, or crutches.

When breathing muscles are paralyzed, doctors may u a mechanical device such as a respirator to help the pient breathe. About two-thirds of such patients recove heir natural breathing. Marianne Schuelein

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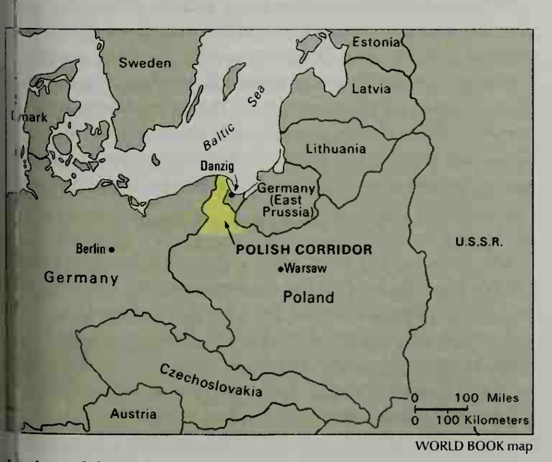
Dease (table)	Roosevelt, Franklin D. (The Warm Springs Foundation)
Eers, John F.	Sabin, Albert B.
Imunization	Salk, Jonas E.
In lung	Virus
Kny, Elizabeth	
Mrch of Dimes Birth Defects oundation	

Plish Corridor was a narrow strip of territory taken fm Germany and granted to Poland after Germany's deat in World War I (1914-1918). The Treaty of Verslles, which officially ended the war with Germany, estlished the corridor in 1919 to give Poland direct accs to the Baltic Sea. The area of the corridor was once pt of a Polish region called Pomerelia.

Prussia gained the territory in 1772. The region came uler German control when Prussia became a German se in 1871. The largely agricultural region included tl towns Bydgoszcz, Grudziadz, and Toruń and the seapt Gdynia.

The corridor separated the East Prussia area of Germny from the rest of Germany. About half the people in tl region spoke German, and Germany and Poland cne to dispute ownership of the territory. In 1939, Germy regained control of the corridor. The corridor and h of East Prussia became part of Poland in 1945, after Vrld War II ended. Christoph M. Kimmich

See also **Gdańsk**; **Poland** (History).



WORLD BOOK map

Lation of the Polish Corridor

Pish lowland sheepdog is a breed of dog develod in Poland to herd sheep. It stands 17 to 20 inches (o 51 centimeters) tall at the shoulders and weighs fn 35 to 50 pounds (16 to 23 kilograms). The dog originated in northeastern Poland, possibly as early as the A.D. 1200's.

This breed has a strong, muscular body with a broad neck and large legs. Its hair grows long and thick, especially on its forehead, cheeks, and chin. The dog's coloring varies from individual to individual. Common color patterns include white with black, gray, or sandy patches; and gray with white or chocolate brown patches.

Polish lowland sheepdogs nearly became extinct during World War II (1939-1945). But today, people throughout the world own these dogs as pets and as herding dogs. Polish lowland sheepdogs can make loyal, intelligent companions.

Critically reviewed by the American Polish Lowland Sheepdog Club

See also **Dog** (picture: Herding dogs).

Polish Succession War. See Succession wars (The War of the Polish Succession).

Polishing. See Grinding and polishing.

Politburo, *puh LIHT BYUR oh,* or *PAHL iht BYOOR oh,* was the political bureau of the Central Committee that controlled the Communist Party of the Soviet Union from 1919 to 1991. V. I. Lenin, the country's first leader, set up the Politburo. Before 1990, the Politburo included the most powerful members of the party, and all important decisions in the Soviet government needed the Politburo's approval. But in 1990, the Politburo's power was greatly reduced when its role was limited to the development of party policy.

In August 1991, several Communist officials failed in an attempt to overthrow Soviet president Mikhail Gorbachev and take control of the government. After the attempt, the Soviet parliament suspended all Communist Party activities, including those of the Politburo. In December 1991, the Soviet Union broke up into a number of independent states. The name *Politburo* also is used for similar groups in other Communist countries.

Stuart D. Goldman

See also **Union of Soviet Socialist Republics** (Government); **China** (The Communist Party).

Political action committee is a group set up by a labor union, corporation, or other organization to contribute money to candidates for federal and state offices in the United States. Political action committees, often called *PAC's,* are formed largely because U.S. law forbids certain organizations to make contributions directly to candidates. PAC's get their money from individuals, in most cases from members of the group that formed the PAC. The first PAC's were established in the 1940's.

Federal law and some state laws limit the money a PAC may contribute to each candidate in an election. But the contributions may be repeated for each election, whether it is a primary or a general election. A PAC may also donate unlimited amounts to a political party.

Many people think PAC's have too much influence in American politics. They say that to raise campaign funds, officeholders may give more attention to issues that concern PAC's than to those that concern ordinary citizens. Also, PAC's donate mostly to candidates seeking reelection. Many people therefore believe PAC's reduce the competitiveness of elections by making it harder for challengers to win. Defenders of PAC's say they help citizens exercise their right to support political candidates and to communicate their concerns to public officials.

Bruce I. Oppenheimer



AP/Wide W

At a national political convention, delegates nominate their party's candidates for president and vice president. This crowd of delegates, lobbyists, and supporters celebrates the nomination of Texas Governor George W. Bush at the Republican Party convention in Philadelphia in 2000.

Political convention is a gathering at which major political parties in the United States formally nominate their candidates for president and vice president. At one time, the conventions actually selected, as well as formally nominated, the party's candidates. Today, however, the presidential nominees of the major parties are normally determined before the convention takes place. Nonetheless, the conventions of the Democratic and Republican parties—the two major political parties—play an important role in the U.S. presidential election process. The conventions allow the party to unify around its nominees. Equally important, the conventions provide wide public exposure for the party's candidates and goals. A successful convention can dramatically boost the public's support for the party and its candidates.

The Democratic and Republican national conventions are four-day events that take place every four years. The two conventions are held at separate times during the summer of each presidential election year. They are typically held in separate cities, and in different cities from year to year.

Huge crowds gather at each convention. The people in attendance include thousands of party delegates, who nominate a candidate they hope can win the presidential election the following November. An even larger number of magazine, newspaper, radio, and television reporters come to the convention. They provide coverage of the gathering for millions of voters throughout the nation. Many other people attend conventions, including *lobbyists* (representatives of interest groups), people who contribute money to the party or its candidates, and alternate delegates.

The first national political conventions in the United States assembled in the early 1830's. The presidential candidate was both selected and nominated at the convention until the mid-1900's. Today, the candidate is normally selected before the convention in a series of state elections and other contests. These contests determine the number of supporters each candidate will have at the convention as delegates. The candidate with the most delegates is formally nominated at the conventio The delegates then nominate a vice presidential candi date, who normally has been hand-picked by the pres dential candidate.

Other business is also handled at the convention. Fo example, the party adopts a *platform*—a statement of i goals and principles in the presidential campaign. The platform is designed to win votes for the presidential and vice presidential nominees, and for party candidates who are running for other political offices in the same election year.

Political conventions are lively events. Delegates su port their choice for president and vice president by waving banners and cheering wildly. Parades, parties, and other celebrations promote the political party an its nominees. On the last day of the convention, the presidential and vice presidential nominees give speeches that launch the party's election campaign. Th speeches are broadcast on TV throughout the countr

Preconvention activities

The process of nominating a presidential candidate begins months before the convention. The most impo tant step in the process is the selection of convention delegates. At the convention, each delegate votes for presidential candidate. The candidate who gets a maj ty of the delegate votes wins the party's nomination.

Delegate selection takes place in elections and ot er state contests that occur during the late winter and spring of each presidential election year. Washington D.C., Puerto Rico, and the Virgin Islands and other U.S territories also send delegates to the conventions.

The national committee of each party decides how many delegates each state may send to the conventio The number is based on the party's strength in the sta in recent elections. Thousands of delegates attend ea

›nvention, but exact numbers vary from year to year.
The method of choosing people to run as delegate ındidates is different in different states. In many states, ese candidates are chosen by the state party organiza- ›n, by the presidential campaign organizations, or by ass meetings of supporters of a presidential candi- ıte.

There are two main methods of choosing which dele- ıte candidates will attend the convention as delegates. ıey are (1) the *primary election system* and (2) the *cau- ıs-convention system.* Some states allow each party to ıoose which of the two systems it will use.

Most states require both parties to use the primary ection system. As a result, primary elections deter- ine more than two-thirds of all convention delegates.

Some states hold a *delegate primary,* in which voters ect the delegates. In most delegate primaries, the ımes of the delegate candidate and the presidential ındidate whom the delegate supports are printed to- ›ther on the ballot. In this way, voters know which del- ןate candidate supports which presidential candidate.

Other states hold a *candidate primary,* in which only e names of the presidential candidates appear on the ıllot. The number of votes each candidate receives in e primary determines the number of delegates he or ıe is allowed to send to the national convention.

The caucus-convention system was once the main ethod of selecting delegates to national conventions. ›day, less than one-third of all delegates are chosen in is way. The caucus-convention process begins with cal meetings called *caucuses.* At each meeting, dele- ıtes are chosen to attend a convention that covers a rger region, such as a county. This convention, in turn, lects delegates to a state convention, where the state's ıtional convention delegates are then chosen.

The caucus-convention process may begin with either two types of caucuses—*party caucuses* or *participa- ıry caucuses.* In a party caucus, the delegates sent to e regional convention are chosen by local party offi- ıls. In a participatory caucus, anyone who attends the ucus can take part in choosing the delegates.

Most states do not require individual delegates to ıte for the candidates the delegates have pledged to pport. But delegates rarely change their vote unless eir candidate drops out of the race.

Certain primaries and caucuses are more influential an others in determining who the presidential nomi- ıe will be. The early contests provide the first indica- ıns of which candidates may have a chance to win the ›mination. Candidates who do not win support in the rly contests are unlikely to raise campaign funds, ther campaign workers, or attract media attention. ıese candidates often drop out of the presidential race rly. The Iowa caucuses and the New Hampshire pri- ıry are examples of important early delegate contests.

The large states account for the most delegate votes each party's convention. As a result, the candidates re- ıining after early contests try especially hard to win tes in big states, such as California and Texas.

Organizing the convention is done by the party's tional committee. The committee chooses a perma- nt chairperson for the convention. It also designates a rson to kick off the convention with a rousing speech lled the *keynote address.* Members of Congress or other important party members usually are chosen for these positions. The committee also picks a convention site.

Much of the convention's official business is carried out by special committees. Most of the committees consist of delegates and other party members, including some elected government officials.

The special committees meet in the months before the convention. One committee prepares a report that establishes procedures for the convention, and another makes sure the state delegate contests have conformed to party rules. Yet another committee drafts a party platform.

Convention activities

The main purpose of a national convention is to nominate candidates for President and Vice President. But the convention also serves other purposes. Today, one of its most important functions is to present the party's platform and candidates to the nation's voters. To reach the voters, the party encourages television, newspaper, and other reporters to cover key events at the convention.

Introducing the campaign. Much of a national convention of the Democratic or Republican parties is devoted to speeches. These speeches include the keynote address. This speech, made by an important party member, sets out themes for the presidential campaign. It is also intended to inspire party members for the hard work needed to win the November election.

The presidential candidates who will not receive the party's nomination often deliver speeches. In most cases, they use their speeches to announce their support for the person who will become the nominee.

Also at the convention, the special convention committees present their reports for adoption by the convention delegates. Most reports are drafted before the convention and do not change once it begins. But some reports are adopted only after debate. General party reaction to the reports can influence the presidential race. For example, the report that presents the party's platform must appeal to a wide range of voters—as well as to party members. Disagreement on the platform at the convention may reveal a lack of party unity and thus make the party and its nominees less attractive to the nation's voters.

Making nominations. The presidential nomination is one of the highlights of the convention. Delegates officially recommend the nomination of candidates in *nominating speeches,* in which the speaker praises the accomplishments of the candidate. Each speech may build to a climax that triggers a massive demonstration in the convention hall. Delegates and other supporters of the candidate parade, wave banners, throw confetti, and cheer.

The *roll call* begins after all nominating speeches have been made. In the roll call, each state and territory casts a ballot that indicates how many of its delegate votes it is awarding to each candidate. The candidate who gets a majority of the votes of all the delegates at the convention formally becomes the party's nominee.

If no candidate receives a majority, more ballots would be cast until enough delegates switch their votes to give one candidate a majority. However, a second ballot has not been required at any Democratic or Republi-

can national convention since the early 1950's.

To nominate a candidate for Vice President, the party uses the same procedure that it used for the presidential nomination. The likely nominee for President normally chooses the vice presidential nominee before the convention begins. The delegates then approve the choice at the convention.

The nominees for Vice President and President make *acceptance speeches* near the end of the convention. These speeches are viewed on television by millions of people. The speeches outline the issues that will be emphasized during the campaign and are designed to win the confidence of voters. With their speeches, the nominees also try to rally the enthusiasm of party members who may have supported other candidates during the nominating campaign.

Other convention activities. Numerous other activities also take place at a national convention. For example, state party leaders attend the convention to discuss issues affecting the party in their state. Also, many of the party's candidates for election to Congress or to state or local offices campaign at the convention. Lobbyists attend the convention to try to influence delegates and party leaders or to use news coverage of the convention to further their causes.

Attracting publicity. National news coverage of the presidential candidate and the party has become a major goal of the organizers of political conventions. Both major parties rely on newspaper articles, television stories, and other press coverage to generate public support for their nominees.

All national conventions of the Democratic and Republican parties have been televised since 1952. The parties often schedule convention events to occur at peak TV viewing hours.

Measuring convention success. A convention's success was once measured chiefly by how well the convention promoted party unity. The convention was judged successful if it ended with party members from the various states supporting a single presidential candidate.

Today, however, the success of a convention is more often measured in terms of how much the convention contributes to the public image of the nominee. The party compares opinion polls taken before and after the convention to determine how the convention has affected the nominee's public approval rating. Because of media coverage of the convention, the nominee's rating almost always rises. But the extent of this rise can vary a great deal from convention to convention. A large upward "bounce" is the sign of a successful convention.

The history of national conventions

The writers of the Constitution of the United States did not outline a procedure for nominating a President. Until the early 1830's, a party's supporters in Congress or in state legislatures usually nominated the party's candidate for President.

The Anti-Masonic Party held the first national nominating convention in September 1831. The first convention that closely resembled today's gatherings was that of the Democratic-Republican Party in 1832. Soon, the convention became the established procedure in the United States for nominating presidential candidates.

The changing role of conventions. Until the mid-1950's, almost all presidential nominees were not only formally nominated at the convention, but they also fought there for the support required to win the nomination. Usually, strong candidates assembled some support before the convention. Then, at the convention, they competed with one another to win a majority of the delegates' votes. Party leaders often had significant influence in maneuvering the votes of the delegates. At many conventions, multiple ballots were needed to reach a majority. In 1924, the Democrats took 103 ballots to nominate John W. Davis—the largest number of ballots ever needed at a Democratic or Republican presidential convention.

By the mid-1950's, however, delegate majorities had begun to form before the convention. The last time a major party had to go to a second ballot was in 1952, when the Democrats needed three ballots to nominate Adlai E. Stevenson.

Various factors contributed to this change. For example, the ability of party bosses to influence the nomination had diminished because of new laws on delegate selection in the early 1900's. This legislation included several state laws that required the parties to select their convention delegates in primary elections.

As a result of these and other changes, candidates increasingly turned to campaigning among voters for support. The spread of TV after 1945 helped these candidates achieve national recognition and aided the formation of earlier and earlier nominating majorities.

Further reforms of the convention system took place soon after the 1968 Democratic convention. Many people viewing the convention, in which Hubert H. Humphrey won the nomination, disliked the political maneuvering they saw on the convention floor. Consequently, the Democrats appointed a commission to reform their rules for selecting convention delegates.

One result of the reforms was greater representation of minority groups and women among the delegates. The reforms also resulted in many states adopting laws that required the use of primary elections by both Republicans and Democrats. Although primaries had appeared in the early 1900's, they did not become the main method of delegate selection until after 1968.

Other types of conventions

State and local party conventions may be held to select party leaders, adopt local and state party platforms, or endorse nonpresidential candidates in primary elections. In addition, the constitutions of most states provide for a constitutional convention, often called a *con con.* The purpose of such a convention is to rewrite or revise the state constitution. The people of the state elect the con-con delegates. In most states, the people must approve the new or revised constitution before it can take effect. Byron E. Shafer

Related articles in *World Book.* For tables showing all the presidential and vice presidential candidates of the Republican and Democratic parties, see **Democratic Party** and **Republican Party**. See also:

Caucus	Political party	Unit rule
Delegate	President of the United States	Vice President of the United States
Election campaign	Primary election	
Electoral College		

Political economy is economics. See Economics.



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A olitical party works to gain or maintain control of a government. One way political parties su ort themselves is by raising money at fund-raising dinners, such as the one shown above.

Political party

P itical party is an organized group of people who c trol or seek to control a government. In democratic c ntries, political parties compete against one another in lections to keep or gain control of a government. In th United States and Canada, political parties are active o he national, state or provincial, and local levels.

olitical parties are absolutely necessary to demo- cr ic government. Most modern democracies are *rep- re ntative* democracies. That is, the people elect repre- se atives to act as their agents in making and enforcing la . In a representative democracy, some means is n ded for nominating candidates for public office and fo electing issues for public debate. Political parties p orm these functions. At election time, the people v into office the candidates of their choice. Political p ies are voluntary organizations and want as many m bers as possible. Some of these parties have rules a membership dues. Others have practically no rules a require no dues.

lost dictatorships allow only one political party—the p y that controls the government. That party also ti ly controls who may run for election.

Party functions

democratic countries, political parties perform sev- e important tasks. (1) They select candidates to run for p lic office. (2) They help organize the government. (3) T provide opposition to the party in power. (4) They ra funds to conduct election campaigns. Other func- ti of parties in democratic countries include inform- in voters about public affairs and about problems that n d government action. In one-party nations, the chief fu tions of political parties are to select candidates for office and organize the government.

Selecting candidates. In one-party nations, the candidates the party selects to run for office automatically win election because they have no opposition. In China, for example, the Communist Party—the only party allowed—chooses the candidates for office.

In nations that have two or more parties, each party selects candidates for the various public offices. The voters then decide which candidates among the parties win office. Party leaders try to select candidates who have voter appeal and experience for the office.

During the early history of the United States, party leaders selected candidates for office in meetings called *caucuses.* But the caucus system became unpopular because it gave other party members little voice in the selection of candidates. In addition, one person or a small group of persons sometimes gained control of a caucus and used it for private gain. See **Caucus.**

By about 1840, the *convention system* for nominating candidates was in general use. Under this system, party members chose delegates to represent them at nominating conventions. But party bosses and *political machines* (organizations within a party) gained control of many conventions. Many delegates voted the way they were told or paid to vote. Today, conventions are held in only a few states to make some nominations for state and local offices and to discuss party affairs. The two major U.S. political parties—the Democratic and Republican parties—still hold a national convention every four years to officially nominate candidates for President and Vice President. See **Political convention.**

During the early 1900's, many states began to replace the convention system with primary elections to select candidates for office. The aim was to reduce party control in the selection of candidates. Today, all states hold either *open* or *closed* primary elections for state offices. In an open primary, each voter receives the ballots of all parties holding primaries. In the voting booth, the voter selects which ballot to use. In a closed primary, voters receive only the ballot of the party to which they belong. In recent years, the Republican and Democratic parties

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have relied on primary elections—and, in some states, caucuses—to select their presidential candidates. The parties then formally nominate the candidates at their national conventions. See **Primary election.**

Organizing the government is a major function of political parties. But how the parties do this depends on the government's established structure and on how the powers of government are divided.

Unitary and federal systems. In countries that have a *unitary* system of government, such as France, Italy, and the United Kingdom, the central government has most governmental powers, including control over local governments. In countries that have a *federal* system of government, such as Canada and the United States, the powers of government are divided between the central government and the state or provincial governments (see **Government** [Systems of government]). The political parties in countries with a unitary system concentrate on gaining control of and organizing the central government. The parties are thus basically national in their activities and are so organized. The political parties in countries with a federal system try to gain power to organize both the central government and the state or provincial governments. The parties are thus both national and state in their activities and organization.

The presidential system. In the United States, the Constitution provides for the separation of powers among the executive, legislative, and judicial branches. The President, therefore, is not a member of Congress, nor are the Cabinet members. The President is elected by the people through the Electoral College and may be of a different political party than the party that controls Congress. Often, the President is forced to rely on leaders from both parties to get programs passed. Under the presidential system, Congress may refuse to pass legislation the President wants. On the other hand, the President may *veto* (reject) legislation passed by Congress—and Congress seldom overrides a veto.

The President serves a four-year term. The President has to deal with a House of Representatives whose total membership is elected every two years and with a Senate in which a third of the members face election every two years. These staggered elections make for shifting alliances and may increase or decrease support for th President's policies. The *bicameral* division of Congre into two independent bodies—the House of Represer tives and the Senate—also complicates the President's role. Traditionally, each body jealously guards its pow ers against executive interference.

The parliamentary system. In such parliamentary d mocracies as the United Kingdom, the head of the go ernment —the prime minister—faces fewer problems organizing the government. The prime minister must a member of Parliament and usually also is leader of t majority party in the House of Commons. The prime minister usually chooses a Cabinet from leaders of th majority party who are members of Parliament.

In the United Kingdom, the prime minister and Cab net thus have both executive and legislative authority. They are members of the legislature and responsible it. If the prime minister's program fails to win parliam tary support, the opposition party may demand an ele tion. This election is called for by the government but must occur within five years of the previous election. The people will vote either to keep the present gover ment in power or to give the opposition party the op portunity to form a new government.

Organizing the U.S. Congress. The Democratic and Republican parties organize their members in Congr according to the established structure of the House o Representatives and the Senate. At the beginning of each new session of Congress, both parties in the House and the Senate hold meetings to elect various ficers and committee members. In the House, each p nominates a candidate for Speaker, the body's presid officer. But most representatives vote for their party's candidate, and so the majority party actually chooses Speaker (see **Speaker**). In the Senate, the Vice Presid of the United States presides. The majority party elec president *pro tempore* (temporary) to preside in the a sence of the Vice President.

Each party in the House and Senate also elects a *fl leader* and a *whip.* The floor leaders direct their party activities during debates on proposed legislation. Th whips help the floor leaders by letting them know ho party members feel about bills coming up for vote. T

Important political parties of the United States

This chart shows the time spans of some of the important political parties of the United States. A question mark means the date is disputed by political historians. For charts showing when each of the two major parties was in and out of office, see the articles on Democratic Party and Republican Party.

Republican Party (1854-)
Democratic Party (1830?-)
National Republican Party (1825-1834)
Democratic-Republican Party (1792?-1825?)
Federalist Party (1787?-1816?)
Greenback Party (1874-1
Anti-Federalist Party (1787?-1792?)
Whig Party (1832-1860)

1788 1796 1804 1812 1820 1828 1836 1844 1852 1860 1868 1876

/hips—with the help of assistant whips—also try to as- ıre as much party discipline as possible by persuading ıembers to vote along party lines.

The majority party in each house has the most seats n House and Senate committees. In addition, the com- ıittee heads belong to the majority party. Congression- committees and subcommittees have great influence ı speeding or slowing the passage of legislation. They re often called "little legislatures." See **Congress of the** **nited States; House of Representatives; Senate.**

Providing opposition. In a democratic nation, the ırty or parties out of power have the duty of criticizing ıe policies of the party in power and offering alterna- ve programs. In France, Italy, and other countries that ave many parties, the opposition parties may represent ırious points of view—from those favoring a monarchy those preferring Communism. In most two-party na- ons, the party out of power usually provides unified pposition. But in the U.S. Congress, this is not always ue. Some members of the party that does not control e presidency may support the President's program gainst the wishes of their party leaders.

Raising funds for election campaigns is an important :tivity of political parties in democratic nations. Cam- ıigns are expensive, but parties must wage them to in elections. United States parties spend much more oney on election campaigns than do parties in other ıtions, partly because most U.S. campaigns last longer ıd employ television and other costly means of com- unication. It can cost millions of dollars to finance a ımpaign for a U.S. Senate seat in a large state, and any millions more to finance a presidential campaign. ıe cost of nominating and electing all U.S. public offi- als in a presidential-election year is over $1 billion.

Most campaign expenditures are for television and ra- o advertising, campaign consultants, polls, printing ıarges, telephone bills, campaign buttons, posters, and ılaries. Some campaign funds come from the small ontributions of thousands of party members and sup- orters. But most of the money comes from large dona- ons by wealthy people and institutional groups called *olitical action committees (PAC's).*

In the United States, several federal and state laws regulate campaign spending and contributions. But the laws have been difficult to enforce and have been generally ineffective in controlling expenditures because so many groups are involved in waging campaigns and raising funds. See **Election campaign; Hatch Political Activities Act.**

Other functions. In democracies, each party uses newspapers, radio, television, and other means to tell the people about its program. In so doing, a party hopes to win—or stay in—office. The party in power tries to justify its program. The minority party, on the other hand, points out what it considers weaknesses in the majority party's program and offers voters an alternative one. In publicizing their views, political parties thus help keep the voters informed on important issues.

Political parties also simplify complicated issues for the voters by reducing the issues to choices between candidates for office. In order to win votes, political candidates also look for problems that have not received public attention and that affect many people. In this way, political parties help force the government to act on neglected problems.

Party systems

The number of political parties that win a significant share of votes in major elections determines the kind of *party system* that a country has. A country may thus have a one-party, two-party, or multiparty system.

One-party systems are often associated with dictatorships. Most dictatorships allow only one party—the party that controls the government. Some dictatorships permit other parties, but only as long as they create no threat to the government.

In China, the Communist Party forms the government. No other party may exist. Party membership is considered a privilege and is granted only after a person meets certain standards. Only about 4 percent of the Chinese people belong to the party. The party performs many more functions than political parties in democracies. For this reason, it has elaborate organization for recruiting members and leaders, developing policy, indoctrinating the people, and maintaining discipline. See **Communism** (Communism in practice).

WORLD BOOK chart

American Party (1968 - 1976)
ist Party (1891-1908?)
Libertarian Party (1971 -)
Progressive Party (1948 - 1957?)
Reform Party (1995-)
Progressive Party (1924 - 1946?)
Progressive Party (1912 - 1916)
92 1900 1908 1916 1924 1932 1940 1948 1956 1964 1972 1980 1988 1996 2004

Most one-party dictatorships have elections. The elections are held chiefly to generate enthusiasm for the party. In China, for example, the candidates of the Communist Party tell the nation's people how wonderful Communism is. Party leaders explain what the party has done, what it plans to do, and what it expects of the people.

Two-party systems are most common in English-speaking nations. These two-party countries include the United Kingdom, with its Conservative and Labour parties; and the United States, with its Democratic and Republican parties. Although these nations also have other parties, one of the two major parties in each country usually controls the government.

Similar voting patterns also exist in most two-party countries. Generally, industrial areas of a nation support the more liberal party, and rural areas vote for the more conservative party.

Although a nation may have a two-party system, one party may control politics in certain areas of the country. The party has this control because most voters in such areas always vote for its candidates. In the United Kingdom, for example, certain *constituencies* (voting districts) always support the Conservative Party. Some of the country's other constituencies always support the Labour Party. In national elections, each party considers certain constituencies "safe." If party leaders want to be sure that a candidate will win a seat in Parliament, they have the candidate run in a safe constituency. In the United Kingdom, candidates for national office do not have to be a resident of the constituency they hope to represent.

In many states of the United States, both the Democratic Party and the Republican Party have considerable strength. In other states, one of those two parties has traditionally controlled politics. From the American Civil War (1861-1865) until the 1960's, for example, Democrats strongly controlled most of the Southern States. During that same period, the Republicans controlled—though less strongly—some of the New England and Midwestern states. Since the 1960's, however, the Republicans have won increasing support in the South and West, and the Democrats have made gains in New England and in the Midwest.

Large industrial and commercial cities in the United States, such as Chicago and New York City, generally vote for the Democratic Party. Rural areas, on the other hand, usually support candidates from the Republican Party.

Multiparty systems are found in many nations that have parliaments. Countries with multiparty systems include Belgium, Denmark, France, Italy, Japan, and Sri Lanka.

Most multiparty nations have four or five major parties. In addition, a nation may also have many minor parties. In most cases, each party seeks a particular economic or social goal. Multiparty systems vary from country to country. But most systems consist of one or two *left-wing* parties, which hold liberal or radical views; one or two *center* parties, which have moderate views; and one or two *right-wing* parties, which support conservative views.

In multiparty nations, one party rarely wins enough seats in the legislature to form a government. Consequently, two or more parties join forces and form a *coalition government* to direct the nation's affairs. But often, the coalition parties fail to agree on policies and programs, and so the government falls. The multiparty system thus tends to produce a less stable government than does the two-party system.

Party membership in the United States

Political parties in the United States have no strict requirements for membership. People are considered members of the party to which they consider themselves to belong. Therefore, neither the Republican Party nor the Democratic Party maintains accurate membership lists.

Some of the best evidence regarding party affiliation comes from voting surveys and public opinion polls. Such surveys and polls show that the majority of American voters who identify with a political party consider themselves Democrats. But party identification has never meant straight party voting. In the 1980 and 1984 presidential elections, for example, Republican Ronald Reagan received the votes of many people who normally thought of themselves as Democrats. These same people may have voted for Democratic candidates at the state and local levels. Such ticket-splitting is much more common in the United States than in other major countries.

Party organization in the United States

The Democratic and Republican parties are complicated organizations. Both parties are organized at the national, state, and local level. At each level, each party has three basic units. These units are the mass meeting, the committee, and specific leaders. The relationship between the three units varies at the three levels of government. It also varies from one state or community to another.

National conventions and committees. In theory, the national convention of each major political party has final authority in party matters. Actually, however, the convention has little power. Each party's national convention meets only once every four years, when it nominates the party's candidates for president and vice president. The national convention also goes through the formality of electing the national committee, which acts for the party between conventions. In reality, each state party chooses its representatives on the committee. To learn about the organization and activities of the national conventions and how the delegates to the conventions are chosen, see the *World Book* article on **Political convention**.

The national committee of both major parties consists of party representatives from the states, the District of Columbia, and the territories. The Republicans elect a committeeman and committeewoman from each area, and include each area's party chairperson. The Democrats have a much larger committee. Its representatives are apportioned by a complicated formula that is designed to include many special groups and to reflect party strength. Men and women must be equally represented on the committee.

Both the Democratic and Republican national committees have their headquarters in Washington, D.C. They meet only once, twice, or three times a year. One of the

ıain tasks of each committee is to organize its party's ext national convention. It chooses the city where the onvention will meet and makes arrangements for a moothly run convention. But most of the work of the arty's national organization is done by the committee's ational chairman and staff.

Each party's presidential candidate selects the na- onal chairman at the end of the national convention. he national committee then formally elects that person. he chairman acts for the national committee in manag- ıg party affairs. He or she may assist the President in *atronage* matters by recommending appointees for ederal jobs. During presidential elections, the chairman irects the party's fund-raising and other activities in the ational campaign.

The national chairman also organizes the party's na- onal headquarters and is the chief decision maker vithin the national organization. But the headquarters as a sizeable staff that does the detailed work. It has ampaign, fund-raising, public relations, and research ivisions.

State committees. Both the Democratic and Repub- can parties have a state committee in each state. In ıost states, the committee members are chosen in arty primaries or at conventions. The state committees rganize and manage campaigns for state offices and as- ist in local campaigns. They also raise money, make ar- angements for primary elections, and organize the state onventions.

The leader of the state committee is the official head f the state party. The committee formally elects the eader. But the governor, a U.S. senator from the state, r a group of powerful local officials actually hand-pick ıe leader. In most states, these officials are also power- ıl enough to lead the party and control the state com- ıittee. In some states, however, the committee leader ffectively directs the party and controls or even hooses key state party officers.

Local organizations. Each of the two major parties as a county committee in most counties of the United tates. Committee members are chosen by county con- entions or in primaries. The county committee elects ıe county leader, who maintains communication with ıe state party organization and, in most states, is a dele- ate to the state committee. Some county leaders retain atronage power, which they use to sway the votes of elegates at state and national conventions.

Below the county committees are the city, ward, and recinct organizations, whose leaders have the closest ontact with the voters. City and ward committeemen nd committeewomen are selected in local conventions r primaries. In some states, precinct committeemen nd committeewomen or captains are also chosen in rimaries. In others, the county committee selects them.

The United States has more than 146,300 election pre- incts. In most of them, either one or both major parties ave a precinct captain, committeeman, or committee- voman. This official prepares the party *poll book,* which sts the names of the voters in the precinct and which arty—if any—they belong to. Precinct captains and their ssistants try to make sure that all members of their arty are registered to vote.

In the past, precinct captains or committeemen and ommitteewomen frequently won votes by assisting voters and would-be voters. For example, they helped immigrants become citizens, bailed out prisoners under arrest, found jobs for unemployed persons, and sometimes gave out charity. But in many cities, local party leaders and bosses have lost the great influence they once had. Government welfare programs and rapid economic growth have made many voters less dependent on their help.

Development of parties in the United States

Early history. American leaders met in Philadelphia in 1787 to draw up the Constitution. This document makes no mention of political parties. In fact, George Washington, who presided over the Constitutional Convention, and many other early political leaders opposed their development. Nevertheless, common economic, political, and social interests brought people together to form political organizations. A group called the Federalists supported strong national government. Their opponents were called the Anti-Federalists. These political organizations began to take shape before Washington became President in 1789. Soon after, the two groups developed into the first American political parties, the Federalist Party and the Democratic-Republican Party. The Federalists, led by Alexander Hamilton, wanted a strong central government (see **Federalist Party**). The Democratic-Republicans, led by Thomas Jefferson, supported a weak central government (see **Democratic-Republican Party**).

After the 1816 presidential election, the Federalist Party broke up as a national organization, and the Democratic-Republican Party split into several groups. One of the Democratic-Republican groups came under the leadership of Andrew Jackson. By about 1830, Jackson and his followers were known as Democrats.

The Democratic Party is the oldest existing political party in the United States. Some historians believe it began in the 1790's as Jefferson's Democratic-Republican Party. Most historians trace its origin to the campaign organization that formed after the 1824 presidential election to win the presidency for Jackson in 1828.

From 1828 to 1860, the Democratic Party won all but two presidential elections—those of 1840 and 1848—even though its members often disagreed on several issues. They fought, for example, over banking policies, the slavery issue, and tariff rates. Democrats also met bitter opposition from outside the party. About 1832, several groups that opposed Jackson combined to form the Whig Party. But the Whigs never united sufficiently to propose a program with as much popular appeal as that of the Democrats. See **Whig Party**.

During the 1850's, the Democrats split over whether to oppose or support the extension of slavery. In 1860, the party even had two nominees for President—John C. Breckinridge and Stephen A. Douglas. Both lost to the Republican candidate, Abraham Lincoln.

From 1860 to 1932, only two Democrats won the presidency—Grover Cleveland in 1884 and 1892 and Woodrow Wilson in 1912 and 1916. The Republican Party had gained so much strength during the Civil War that the Democrats had great difficulty winning control of the government. In addition, the Republicans repeatedly charged the Democrats with having caused the war and having been disloyal to the Union.

The situation changed after 1929. Just as the Republicans had blamed the Democrats for the Civil War, so the Democrats blamed the Republicans for the stock market crash of 1929 and the Great Depression of the 1930's. The Democrats won the presidency in 1932 and continued to win every election from 1932 through 1948.

In the last half of the 1900's, however, neither the Democrats nor the Republicans dominated the presidential elections to any great extent. The Democrats won 5 out of the 12 elections during that period—in 1960, 1964, 1976, 1992, and 1996. But in the first election of the 2000's, the Democratic candidate lost. For more information, see **Democratic Party.**

The Republican Party started as a series of antislavery political meetings in the Midwest in 1854. At that time, the Whig Party was breaking up. Many Whigs—as well as Northern Democrats—opposed the extension of slavery. The Republican Party represented this viewpoint and thus gained followers rapidly. The party's first presidential candidate, John C. Frémont, ran in the 1856 election. He was not elected president, but he carried 11 Northern states.

From 1860, when Lincoln was elected, through 1928, when Herbert Hoover was elected, the Republican Party won 14 of the nation's 18 presidential elections. The policies of the Republican Party appealed to many groups, including farmers, industrialists, and merchants.

In 1912, President William Howard Taft was the leader of a divided Republican Party. Progressive Republicans wanted Theodore Roosevelt, who had been president from 1901 to 1909, to run again. But conservative Republicans renominated Taft at the party's 1912 national convention. Roosevelt then withdrew from the party and formed the Progressive, or "Bull Moose," Party. This split helped the Democratic candidate, Woodrow Wilson, win the election. The Republicans lost to Wilson again in 1916. They regained the presidency in 1920, and won in 1924 and 1928. But their popularity declined after the stock market crash of 1929.

During World War II (1939-1945), the Republicans began to show signs of recovery. In 1952, World War II military leader Dwight D. Eisenhower brought the Republicans their first presidential victory in 24 years. Eisenhower won reelection in 1956.

The Republicans lost to the Democrats in the 1960 and 1964 presidential elections but regained the presidency in 1968 and held it in 1972. They lost to the Democrats in 1976, but then were victorious in the next three elections—1980, 1984, and 1988. They were defeated in 1992 and 1996. In the first presidential election of the 2000's, the Republican candidate was the winner. For more information, see **Republican Party.**

Third parties. There have been many third parties in the United States. None of them ever won the presidency. But many of their proposals gained such widespread public support that the two major parties were forced to adopt them. These proposals included the convention system of nominating presidential candidates and the direct election of U.S. senators.

Third parties in the United States can be divided into five types, according to their origins and goals. The first type consists of groups that broke away from the two major parties. For example, the Liberal Republicans in 1872 and the Roosevelt Progressives in 1912 broke away from the Republican Party. Third parties that were formed by groups leaving the Democratic Party incluc the Gold Democrats, who left the party in 1896; the Di iecrats, who left in 1948; and the American Independe Party, which split from the Democratic Party in 1968.

The second type of third party consists of organizations formed chiefly to help a specific group of peopl For example, debt-ridden farmers established the Greenback Party in the 1870's and formed the Populist Party in the 1890's.

The third type is made up of left wing protest group They include the Socialist Party, which was founded ir 1901, and the American Communist Party, which was ganized in 1919.

The fourth type consists of parties that have only on goal. These single-issue parties include the nation's ol est existing third party—the Prohibition Party, which w founded in 1869. The Prohibition Party seeks to preven the manufacture and sale of alcoholic beverages in the United States.

The fifth type of third party consists of groups that have broad programs and attempt to gain national fav Examples of this type of third party include the Progre sive parties of 1924, 1948, and 1952; the Libertarian Par which was founded in 1971; and the Reform Party, esta lished in 1995.

Political parties in Canada

Canada has a combined parliamentary and federal system of government. Thus, the organization of its po litical parties resembles that of both the United Kingdc and the United States. Canada—like the United Kingdom—has a prime minister, who usually belongs to an is the leader of the majority party in the House of Com mons. But the political parties in Canada—like those in the United States—are both national and provincial (state) in their activities and organization.

Oldest parties. The two oldest parties in Canada ar the Conservative Party and the Liberal Party. Historicall they have also been the strongest parties. Both parties trace their origins to before 1867, when the British Nor America Act established the Dominion of Canada. In 1942, the Conservatives changed the name of their par to the Progressive Conservative Party. But most Canadi ans still call it the Conservative Party.

In 1867, John A. Macdonald, leader of the Conservative Party, became the first prime minister of Canada. H held office until 1873, when Alexander Mackenzie, hea of the Liberal Party, became prime minister. The Conse vatives regained control of the government in 1878 an held it until 1896. Between 1896 and 1935, one of the tw parties—or a Conservative-Liberal coalition—controlle the government. But since 1935, the Liberals have beer the dominant party in Canada.

Traditionally, the Liberals have favored the expansio of social programs and provincial rights. Conservatives have supported tighter controls on government spending.

Other parties in Canada have never won enough public support to control the federal government. The Liberals and the Conservatives have tried to make their programs broad enough to appeal to other parties.

The Progressive Party was the first Canadian party ot er than the Liberals and Conservatives to win more

t n 20 percent of the vote in a general election. In 1921, i;ained 64 seats in the House of Commons. But by 130, this farmer-supported party was no longer an ef-f tive organization.

n the 1930's, during the Great Depression, two oups of dissatisfied Canadians founded new parties— t: left-wing Co-operative Commonwealth Federation (:F) and the right-wing Social Credit Party. The CCF \'s formed in Alberta in 1932. It supported the estab-l ıment of a planned economy in Canada. The CCF con-t lled the government of Saskatchewan from 1944 to ;4. The party achieved its greatest national strength in 15, with 28 members in the House of Commons.

n 1961, the CCF joined with the Canadian Labour ıngress to form the New Democratic Party (NDP). The DP has considerable influence in British Columbia, lanitoba, Ontario, Saskatchewan, and the Yukon Terri-ty. It governed Saskatchewan during the early 1960's d from 1971 to 1982. It regained control there in 1991. e party held power in Manitoba from 1969 to 1977, m 1981 to 1988, and beginning again in 1999. It head- British Columbia's government from 1972 to 1975 d from 1991 to 2001. The NDP won control of the kon Territory's government in 1985 and controlled ıtario's from 1990 to 1995. The party made its largest ins at the national level in 1963, 1968, 1972, 1979, 1980, d 1988. After 1988, its strength in the House of Com-ıns declined.

The Social Credit Party, established in Alberta in 1935, pports the free enterprise system. This party con-lled the government of Alberta from 1935 to 1971. It verned British Columbia from 1952 to 1972 and from 75 to 1991. In 1962, the party won 30 seats in the use of Commons. But since then, its strength at the tional level has fallen sharply.

Another party, the Reform Party, was established in anitoba in 1987. By the early 1990's, it had gained ıch support across Canada—especially in the West.

In the 1990's, the Reform Party was one of two new rties that sharply increased their number of seats in House of Commons. The other party was the Bloc ıébécois. Founded in 1990 and based in Quebec, it pports sovereignty for Quebec. In the national elec-ns of 1993, the two new parties' gains nearly eliminat- the Conservatives from the House of Commons. The nservatives, however, later regained some of their t strength in the House.

In 2000, members of the Reform Party voted to dis-lve their party and join the newly created Canadian form Conservative Alliance. The new party, common-called the Canadian Alliance, favors such reforms as ducing the national debt and establishing a single-rate come tax. It strongly supports the free-enterprise sys-n. Charles O. Jones

Related articles in *World Book* include:

Political parties

ıerican Party
ti-Federalists
ti-Masonic Party
ti-Monopoly Party
ıc Québécois
nadian Alliance
nservative Party
Constitutional Union Party
Democratic Party
Democratic-Republican Party
Dixiecrat Party
Farmer-Labor Party
Federalist Party
Free Soil Party
Green party
Greenback Party
Labour Party
Liberal Democrats
Liberal Party
Liberal Republican Party
Libertarian Party
Liberty Party
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New Democratic Party
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Progressive Party
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Left wing
Liberalism
Mugwumps
Nonpartisan League
Patronage
Political convention
Populism
Primary election
Proportional representation
Radicalism
Right wing
Socialism
Spoils system
Woman suffrage

Outline

I. Party functions
- A. Selecting candidates
- B. Organizing the government
- C. Providing opposition
- D. Raising funds
- E. Other functions

II. Party systems
- A. One-party systems
- B. Two-party systems
- C. Multiparty systems

III. Party membership in the United States

IV. Party organization in the United States
- A. National conventions and committees
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- C. Local organizations

V. Development of parties in the United States
- A. Early history
- B. The Democratic Party
- C. The Republican Party
- D. Third parties

VI. Political parties in Canada
- A. Major parties
- B. Other parties

Questions

What are the chief functions of political parties in democratic nations?
Why does the multiparty system tend to produce a less stable government than the two-party system?
Which is the oldest existing political party in the United States?
Why is fund-raising an important activity of political parties?
Why do most one-party dictatorships hold elections?
What advantages does the majority party have over the minority party in organizing the U.S. Congress?
What difficulties might a U.S. president face in trying to get a legislative program passed into law by Congress?
What are Canada's two oldest political parties?
How did the Republican Party start in the United States?
In democracies, what are the duties of parties out of power?

Additional resources

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Political prisoner is a person who is imprisoned, detained, or in certain other ways deprived of liberty because he or she opposes the government. There is little agreement on the precise legal definition of the term. For example, some organizations working to free political prisoners specify that such people are prisoners who are persecuted, more than prosecuted, by a government for their political beliefs. Other groups state

that a political prisoner is any person who is detained for posing a threat to government security. Amnesty International, a human-rights organization, seeks to release only those political prisoners who have not committed violent acts.

Treaties between nations protect political prisoners under certain circumstances. Some treaties exempt individuals from *extradition* (being sent to another country for trial) if they are charged with a political offense. Other pacts state that a country will grant political *asylum* (shelter and protection) to certain individuals who seek it. Nations also make agreements with one another to respect human rights within their own borders.

Besides Amnesty International, organizations working to free political prisoners include the International Committee of the Red Cross and the International Commission of Jurists. Surya Prakash Sinha

Political rights. See Citizenship.

Political science is the systematic study of political life. Political scientists seek answers to such questions as "What reasons justify the actions of government?" and "Whose interests are served by governments?" They study various forms of government as well as political parties, pressure groups, elections, international relations, and public administration. All these are activities of individuals and groups and involve basic human relationships. Political science deals with such fundamental values as equality, freedom, justice, and power.

Political science is closely related to economics, history, law, philosophy, and sociology. Economics deals with the control of all material resources, including goods and services, which affects the political power structure within a nation and among groups of nations. History provides much of the raw material with which the political scientist works. Law, especially public law, supplies a framework of formal ideas for the political scientist. Philosophy relates political science to the other sciences. Sociology provides understanding of the social developments that affect political life.

The study of political science has increased greatly with the growth and spread of democracy during modern times. In every democratic country, political science is essential in the processes of government. The political scientist studies these processes and the operations of government agencies and departments. The work of political scientists provides a factual basis for criticism and reform—probably the most important elements of democratic government. Many political scientists participate in government programs as advisers. They also act as consultants to legislators and other public officials. In addition, political scientists develop useful materials for the education of young people. Without that kind of training for future citizens, a democratic society could not prosper.

Fields of political science

In the United States, political science is generally divided into six main fields: (1) political theory and philosophy, (2) comparative government, (3) international relations, (4) American government and politics, (5) public administration, and (6) political behavior.

Political theory and philosophy are usually dealt with historically. Most political scientists believe that the history of political thought forms the basis of all political studies. They consider the reading of great books on political theory and philosophy to be essential for a broad education in politics. The writers of these works include Plato, Aristotle, Cicero, Saint Augustine, Saint Thomas Aquinas, Niccolò Machiavelli, Thomas Hobbes, Jean-Jacques Rousseau, John Locke, Montesquieu, Immanuel Kant, Georg Wilhelm Friedrich Hegel, and Karl Marx.

The classic political and philosophical works help political scientists explore and understand many issues of *empirical politics* (politics based on experience). With this understanding, political scientists can establish generalizations based on verified facts. These generalizations concern such subjects as how power is won or lost and the problems of representative government.

Comparative government. An understanding of political reality may be achieved by comparing the political institutions and practices of two or more countries. Some scholars in comparative government specialize by studying the countries of a particular area of the world.

International relations include diplomacy, international law, and international organization. Since 1945, much emphasis has been placed on the study of the United Nations. Vital forces in the modern world, including imperialism and nationalism, are also important subjects of international relations. In addition, this field of political science deals with defense policies and with problems connected with peace and war. The effects of economic pressures on international relations are studied as well.

American government and politics is a field of political science only in the United States. In Canada, the study of Canadian government and politics would take its place. Political scientists generally give special attention to their own country's government.

The U.S. government has a federal system. Study of the American government deals with national, state, and local government and politics.

American political scientists have made notable progress in arriving at realistic understandings of Congress, the presidency, and the Supreme Court. They have also studied federal government agencies, large corporations, interest groups, the mass media, and other centers of economic and social power. Political scientists have gained important insight into how these groups influence national decision making.

Public administration is actually part of comparative government and of American government and politics. It is separated from those fields because of the range and complications of modern administrative activities. Public administration deals with such tasks of public officials as accounting, budgets, and personnel management. Public officials often work closely with political scientists who are experts in administration. These experts study the departments of the federal, state, and local governments. They analyze how the organization and internal politics of these departments aid or hinder putting political decisions and programs into effect.

Political behavior is the field that explores the way people respond to certain political conditions or influences. For example, the political scientist may take note of how many voters favor a candidate who looks good on television. Behavioral studies are a recent trend in political science. They have been influenced by develop-

ments in such behavioral sciences as anthropology, psychology, and sociology. Political scientists have developed ways to study certain key behavior patterns in politics. Studies have been made in communications, propaganda, voting behavior, and other activities.

The development of political science

The ancient Greek philosopher Aristotle and his teacher, Plato, believed that the main task of political science was to work out a model political order. This political order would establish maximum justice and, at the same time, remain completely stable. Plato was primarily a philosopher of ideas. He derived his insight chiefly from *abstract speculation* (thinking about nonconcrete things). Aristotle, on the other hand, insisted on *empirical studies* (investigation based on experience) in constructing his political theories. See **Aristotle; Plato.**

Scholasticism was a major philosophical movement during the late Middle Ages. Its followers, often called *scholastics,* worked to fit the Greek tradition of political science into the religious framework of Christianity. Their main concern was to harmonize the power of government with ethics and moral laws.

The greatest scholastic was Saint Thomas Aquinas. He ranked all other political subjects below law. In one of his most important works, *Summa Theologica,* Aquinas elaborated Aristotle's theories and adapted them to Christian purposes. Aquinas emphasized certain rights and duties of individuals in the processes of government. He also stressed that government should rule in accordance with those rights and duties. By stating that government was limited by law, Aquinas helped lay the foundation of modern constitutionalism. See **Aquinas, Saint Thomas; Scholasticism.**

Secularism. The theories of the medieval philosophers were challenged in the 1500's and early 1600's. Niccolò Machiavelli, a famous Florentine politician, pushed aside Christian idealism in favor of realistic power politics. Machiavelli's ideas were generalized by Thomas Hobbes, an English philosopher. In Hobbes's view, a person's entire life is a "ceaseless search for power." This approach became known as *secularism* because it separated politics from religion. Three writers who put those ideas into legalistic form were Jean Bodin, a French jurist; Johannes Althusius, a German political scientist; and Hugo Grotius, a Dutch lawyer who founded the science of international law.

Constitutionalism is a political system in which the powers of government are in fact limited by law or tradition. Constitutionalism developed during the mid-1600's as a reaction to *absolutism*—that is, absolute rule by one person. The reaction was especially strong in England, where it was climaxed by the Glorious Revolution of 1688 (see **England** [The Restoration]).

Several English writers influenced the basic theories of Western constitutionalism, including Richard Hooker, John Milton, and James Harrington. John Locke, perhaps the most influential political writer of the time, emphasized basic human rights and believed that people should revolt against governments that violated those rights. His book *Two Treatises of Government* (1690) greatly influenced political thought in the American colonies. Locke's ideas helped shape the Declaration of Independence and the U.S. Constitution.

Liberalism developed as a political philosophy largely from the theories of Locke. Liberalism represents a willingness to change ideas, proposals, and policies to meet current problems. Locke's theories were given a broader base by Montesquieu, one of a group of French writers called the *philosophes.* Liberal theories were reinforced by the radical *individualism* of Jean-Jacques Rousseau and the *utilitarian* theories of David Hume, a Scotsman, and Jeremy Bentham, an Englishman. Individualists believe that freedom of the individual is as important as the welfare of any community. Utilitarians believe that the goal of politics is "the greatest happiness of the greatest number." John Stuart Mill, an English philosopher and economist, summarized most of the liberal ideas that had developed up to his time.

Three great German philosophers contributed liberal ideas that were somewhat different from classic liberalism. They were Immanuel Kant, Johann Gottlieb Fichte, and Georg Wilhelm Friedrich Hegel. The liberalism of Fichte and Hegel included ideas of socialism and nationalism. Kant's liberalism included a theory of universal peace through world organization. Kant explained his theory in *On Eternal Peace* (1795). See **Liberalism.**

Democracy and socialism. Some of Rousseau's writings carried his political theories beyond radical individualism. In *The Social Contract* (1762), Rousseau became the theorist of democracy. His emphasis on the *collective*—the general will, as Rousseau described it—gave rise to socialism. Eventually, the theories about democracy became divided. Liberal, constitutional, democratic ideas were followed in the United States. Socialist democratic ideas became predominant in Europe.

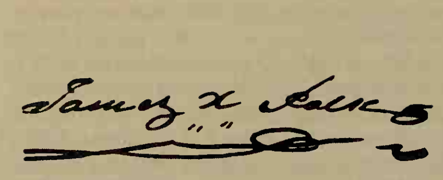
Socialism was further developed by Karl Marx, a German philosopher and economist. He first expressed his socialist ideas in the *Communist Manifesto* (1848), which he wrote with his colleague Friedrich Engels. Communism in the Soviet Union was based on Marxist doctrines as interpreted and modified by V. I. Lenin, who led the Russian Revolution in 1917. Marxism-Leninism differs greatly from the Marxist doctrines followed by democratic socialists in many countries of Western Europe. See **Communism; Democracy; Socialism.**

Contemporary ideas. Since about 1900, most political scientists have sought increasingly to strengthen the empirical basis of their work. They have been returning to Aristotle's view of basing political theories and methods on experience. As a result, much progress has been made in descriptive and analytical work, and in *quantitative studies* (studies that collect data in numerical form), such as opinion polls. Today, political scientists make practical improvement and political reform their major concerns. Many current political studies consider most nations of the world. Such global interests find expression in the International Political Science Association. About 40 national political science associations work together in this organization. Robert L. Cord

See also **Government** and its list of *Related articles.*

Additional resources

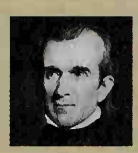
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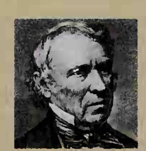
11th president of the United States 1845-1849



Tyler
10th president
1841-1845
Whig



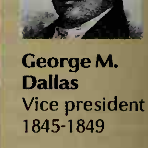
Polk
11th president
1845-1849
Democrat



Taylor
12th president
1849-1850
Whig



Oil painting on canvas (1846) by George Peter Alexander Healy; Corcoran Gallery of Art, Washington, D.C.



George M. Dallas
Vice president
1845-1849

Polk, James Knox (1795-1849), was president when the United States added the greatest amount of new territory to the country. During his presidency, the American flag was raised over most of the area now forming nine Western States, and Texas became a member of the Union. Polk successfully directed the Mexican War, which won much of this territory. He carried out every item of his political program. Of all other American presidents, only George Washington had such a clear record of success.

Polk's era was the "Fabulous 40's." The country seethed with excitement, energy, and prosperity. Covered wagons were crowding the Oregon Trail, heading west across the prairies and mountains to the Pacific Coast. The telegraph, a new wonder, carried news of Polk's nomination. The discovery of gold in California started one of the greatest movements of people in American history. On their way west, the "Forty-Niners" sang such songs as "Be Kind to the Loved Ones at Home" and Stephen Foster's "Oh! Susanna." Such writers as Ralph Waldo Emerson, Henry David Thoreau, Nathaniel Hawthorne, Henry Wadsworth Longfellow, James Russell Lowell, John Greenleaf Whittier, and Edgar Allan Poe produced the "Golden Age of American letters."

The national scene had its unpleasant side, too. Reformers called attention to the hardships of children working in factories and to the poverty of immigrants. Slavery rested uneasily in the thoughts of many Americans. A lack of concern by Polk for these social problems made reformers dislike him. They regarded him as a tool of the slaveowners. Their unfriendly writings outlived Polk's reputation for success. This explains why, for a time, history held Polk in low regard.

Although Polk was a close friend and follower of the great statesman Andrew Jackson, he lacked Jackson's personal attraction. Polk was a cold, silent, narrow, and ungenerous person. He did not seek a second term, and few people regretted it.

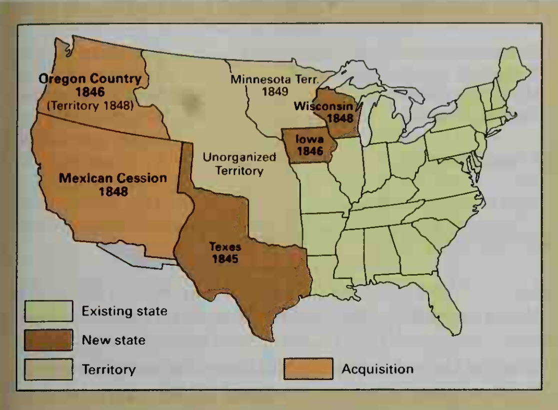
The nomination of Polk by the Democratic Party in 1844 surprised the nation. But Polk defeated the Whig candidate, the famous Henry Clay, because he understood the desire of Americans to see the United States become more powerful. Like most Americans of his day, Polk believed it was the "manifest destiny" of the United States to expand across North America. In this sense, he appears to deserve the tribute of George Bancroft, the great historian who served as his secretary of the Navy. Bancroft called Polk "prudent, farsighted ... one of the very foremost of our public men, and one of the very best and most honest and most successful presidents the country ever had."

Early life

Childhood. James Knox Polk, the son of Samuel Polk and Jane Knox Polk, was born on Nov. 2, 1795, on a farm near Pineville, North Carolina. The Polks had emigrated from Ireland to America. The family name was originally *Pollock* or *Pollok*. In time it became *Polk,* after being repeatedly mispronounced *Poll'k*.

In 1806, Samuel Polk moved his large family to the fertile Duck River Valley in central Tennessee. He combined farming and surveying with land speculation and became one of the wealthiest men of his region.

James, the oldest of 10 children, was a small and sickly boy. His parents spared him many of the chores done by most farm boys. But James learned to help his father survey and manage the large farms. He later worked briefly as a clerk in a general store.



Western acquisitions during Polk's presidency extended the U.S. border to the Pacific Ocean. Three states—Texas, Iowa, and Wisconsin—joined the Union during the period.



The U.S. flag had 30 stars when Polk left office. Stars were added for Florida, which became a state just before he took office, and for Texas, Iowa, and Wisconsin.

The world of President Polk

"Manifest destiny" was a phrase used to justify the territorial expansion of the United States during the 1840's. The phrase expressed the belief that the United States should rule all of North America because of the nation's growing population and its economic and political superiority.
Edgar Allan Poe won popularity with his volume of poetry, *The Raven and Other Poems,* published in 1845.
Clipper ships were launched for the first time during the mid-1840's. Many of these swift, graceful vessels sailed from the east coast of the United States, around the tip of South America, and on to China to pick up loads of tea.
A potato famine in Ireland caused about 1 $\frac{1}{4}$ million Irish to immigrate to the United States in the mid-1800's.
American composer Stephen Foster wrote many songs for minstrel shows, which first became popular in the 1840's. His best-known tunes included "Oh! Susanna" and "Swanee River."
Mormons led by Brigham Young founded the State of Deseret (now Utah) in the Great Salt Lake valley in 1847.
Liberia became the first black republic in Africa in 1847.
The discovery of gold in California in 1848 triggered the nation's first great gold rush.
The Communist Manifesto was issued by Karl Marx and Friedrich Engels in 1848.
The first Woman's Rights Convention was held in Seneca Falls, New York, in 1848 under the leadership of Lucretia Mott and Elizabeth Cady Stanton. Delegates discussed women's rights in such areas as divorce, property control, and voting.

WORLD BOOK map

Education. Polk studied for a year in the Zion Church in Maury, then entered the Murfreesboro Academy. In 1815, he entered the sophomore class of the University of North Carolina. He graduated at the top of his class in 1818.

After graduation, Polk returned home and entered the law office of Felix Grundy, one of the foremost lawyers and politicians in Tennessee. Grundy introduced him to Andrew Jackson. After a year of study, Polk was admitted to the bar in 1820. He began to practice in Columbia and soon had all the cases he could handle.

Political and public activities

Lawyer and legislator. Politics proved more attractive than law. Polk's short height and his speeches on behalf of the Democratic Party won him the nickname of "Napoleon of the Stump." In 1821, while still practicing law, he became chief clerk of the Tennessee Senate. He was elected to the Tennessee House of Representatives in 1823. There he worked to improve the state school system and to reduce taxes. More important to his future, he decided to support Andrew Jackson's presidential ambitions. "Old Hickory" took a keen interest in Polk's political career. The two men became so close that Polk received the nickname of "Young Hickory."

Polk's family. In nearby Murfreesboro, Polk met and courted Sarah Childress (Sept. 4, 1803-Aug. 14, 1891). She was the daughter of a well-to-do country merchant. She had been brought up in a strict religious environment and attended the Salem Female Academy, founded by the Moravian Church. She and Polk married in a large country wedding on New Year's Day in 1824. Mrs. Polk encouraged her husband's political career, and she proved to be his closest political adviser throughout his career. Mrs. Polk was devoted to Jackson, whom she called "Uncle Andrew." In turn, Jackson called her "Sally." The Polks had no children.

Congressman. In 1825, Polk was elected to the first of seven consecutive terms in the United States House of Representatives. He was one of its youngest members and quickly established himself as a loyal Democratic Party man. He attracted attention by his bitter opposition to the policies of President John Quincy Adams, who had defeated Jackson in 1824.

In 1835, during Jackson's presidency, Polk became speaker of the House. He worked hard, and in 14 years as a congressman was absent only once. During his three years as speaker, Polk claimed that he had "to decide more questions of parliamentary law and order" than all his predecessors combined.

Governor. In 1839, Jackson persuaded Polk to run for governor of Tennessee. Jackson felt that only Polk could unite the state Democratic Party, which had been torn by internal strife and by Whig victories of the previous four years. Polk won the election. In his inaugural address, he announced that he supported states' rights and slavery and opposed the centralization of powers in Washington.

Important dates in Polk's life

1795	(Nov. 2) Born near Pineville, North Carolina.
1806	Moved to Tennessee.
1824	(Jan. 1) Married Sarah Childress.
1825	Elected to the U.S. House of Representatives.
1835	Elected speaker of the House.
1839	Elected governor of Tennessee.
1844	Elected president of the United States.
1849	(June 15) Died in Nashville, Tennessee.



Detail of an oil portrait; James K. Polk Memorial Association

Sarah Childress Polk was a deeply religious, well-educated woman. She assisted her husband throughout his career and became his closest political adviser.

Polk shunned the social life of the state capital. He complained that he "could not lose half a day just to go and dine." He lost his bid for reelection in the Whig landslide of 1841. He ran again in 1843, but lost.

Meanwhile, Polk's interests had shifted back to the national scene. He felt he had Jackson's support for the vice presidency. He probably toyed with the idea of the presidency, but neither he nor anyone else took his chances for that office seriously in 1843.

Election of 1844. A combination of circumstances now played into Polk's hand. Former President Martin Van Buren was again the leading candidate for the Democratic nomination. The annexation of Texas was the chief political issue of the day. Van Buren opposed immediate annexation because it might lead to war with Mexico. This position cost Van Buren the support of the West and of the South, which sought to expand slave territory. Polk cleverly argued that Texas and Oregon had always belonged to the United States by right. He called for "the immediate reannexation of Texas" and for the "reoccupation" of the disputed Oregon Territory.

At the Democratic presidential convention of 1844, Van Buren failed to win the two-thirds vote then required for nomination. The delegates could not agree on Van Buren or his chief rival, Lewis Cass of Michigan, a former U.S. minister to France. On the eighth ballot, the historian George Bancroft, a delegate from Massachusetts, proposed Polk as a compromise candidate. On the next roll call, the convention unanimously accepted Polk, who became the first "dark horse," or little-known, presidential candidate. The delegates selected Senator Silas Wright of New York for vice president. But Wright, an admirer of Van Buren, rejected the nomination. This was the first time a man actually nominated for vice president refused to run. The Democrats then nominated George M. Dallas, a Pennsylvania lawyer.

Polk was not well known nationally, and many people

Polk's election

Place of nominating convention	Baltimore
Ballot on which nominated	9th
Whig opponent	Henry Clay
Electoral vote*	170 (Polk) to 105 (Clay)
Popular vote	1,339,494 (Polk) to 1,300,004 (Clay)
Age at inauguration	49

*For votes by states, see Electoral College (table).

asked, "Who is James K. Polk?" This question became a Whig campaign slogan. The Democrats countered with their slogan of "Fifty-Four Forty or Fight!" They meant that the United States should have the entire Oregon Territory, north to the latitude of 54° 40', even if the country had to go to war with the United Kingdom for it.

The Whigs nominated former Senator Henry Clay of Kentucky for president and chose Senator Theodore Frelinghuysen of New Jersey for vice president. Polk, a relative unknown, was opposing a man who twice had run for the presidency and lost. Clay tried to keep the Texas issue out of the campaign because he feared he would lose the Northern antislavery vote if he supported annexation. Polk took a forthright position for annexation. He won the election by about 40,000 votes.

Polk's administration (1845-1849)

A cold, steady rain swept the unpaved streets of Washington during Polk's inauguration. The new president confided to Bancroft, whom he had appointed secretary of the Navy, that "there are four great measures which are to be measures of my Administration." Polk's four goals were to: (1) reduce the tariff, (2) reestablish an independent treasury, (3) settle the Oregon boundary dispute with the United Kingdom, and (4) acquire California. He was to achieve all these objectives.

Life in the White House changed greatly during Polk's administration. The Polks held informal evening receptions twice a month in the Executive Mansion, where gaslights for the first time replaced oil lamps and candles.

As first lady, Mrs. Polk continued to take an active interest in political affairs. A keen editor, she looked over and approved her husband's writings. She read newspapers and clipped items for her husband to see.

Because of Mrs. Polk's strict religious beliefs, she and the president refused to attend the theater or the horse races. Mrs. Polk banned dancing, card-playing, and alcoholic drinks from the White House. She also refused to permit visitors in the White House on the Sabbath. Polk even declined to accept the credentials of the Austrian minister who called on him at the White House on a Sunday. The Polks attended the First Presbyterian Church regularly, although Polk himself joined no church until shortly before he died.

Tariff reduction. Polk had long favored a tariff for revenue only, with "protection being incident and not the object." Robert J. Walker, Polk's secretary of the treasury, drafted a tariff law, and Congress passed it in 1846. The Walker Tariff included some protective features. But it admitted tea and coffee duty-free and also generally lowered rates. This law was the first tariff to be drafted by the executive branch of the government and

Vice president and Cabinet

Vice president	*George M. Dallas
Secretary of state	*James Buchanan
Secretary of the treasury	Robert J. Walker
Secretary of war	William L. Marcy
Attorney general	John Y. Mason Nathan Clifford (1846) Isaac Toucey (1848)
Postmaster general	Cave Johnson
Secretary of the navy	*George Bancroft John Y. Mason (1846)

*Has a separate biography in World Book.

the first to be based on the value, rather than on the quantity, of imports.

An independent treasury. Less than a week after passing the tariff bill, Congress set up an independent treasury to hold and disburse federal funds. Subtreasuries were established in several major cities. President Van Buren had persuaded Congress to create such federal depositories, independent of private business and state banks. But the Whigs had repealed the law in 1841. The Independent Treasury Act of 1846 formed the basis of the nation's fiscal system until Congress passed a law that established the Federal Reserve System in 1913 (see **Federal Reserve System**).

"Oregon fever" swept the country in the early 1840's. Beginning in 1843, thousands of pioneers journeyed along the Oregon Trail and settled along the banks of the Willamette and Columbia rivers in the Oregon Territory. The British, who were strongly established north of the Columbia, claimed the entire territory. The dispute between the United States and the United Kingdom had been "settled" in 1818 by an agreement for joint occupation. Now many members of Congress demanded an end to that agreement. They clamored for American possession of the territory, all the way north to the latitude of 54° 40'.

During the 1844 presidential campaign, Polk maintained that title to the Oregon Territory was "clear and unquestionable" because of American settlements there. As president, he modified his position. He did not want to fight the United Kingdom over the disputed territory, particularly because war with Mexico appeared near. But he confided in his diary that "the only way to treat John Bull is to look him straight in the eye." First, Polk renewed an earlier offer to compromise on the 49th parallel. The United Kingdom rejected the offer, but later made the same proposal, which became the basis of the Oregon Treaty of 1846. See **Oregon Territory**.



New York Public Library

The Mexican War achieved Polk's goal of acquiring California for the United States. This picture shows the victorious entrance into Mexico City of American General Winfield Scott.

The Mexican War achieved the fourth of Polk's goals, the acquisition of California. Earlier he had offered to buy California from Mexico. But Mexico had no intention of selling, particularly because it was then engaged in a dispute with the United States over Texas, a former Mexican possession.

The United States had annexed Texas, but Mexico refused to give up its claims or agree to a boundary for the new state. Polk then ordered American troops to occupy disputed territory south of the Nueces River. American General Zachary Taylor advanced to the bank of the Rio Grande. On April 25, 1846, Mexican troops crossed the river near Matamoros and battled American cavalry. Many historians believe that Mexico had a valid claim to the land where the battle took place. But on May 11, Polk asked Congress to declare war, saying that "Mexico has passed the boundary of the United States, has invaded our territory, and shed American blood on American soil."

The Mexican War ended in an American victory. Under the peace treaty signed in 1848, Mexico gave up all claims to Texas and also ceded land forming all or part of present-day Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming. The United States paid Mexico $15 million for the land and also took responsibility for paying $3 million in damage claims made by American citizens against Mexico.

"The Polk Doctrine." A few months after the Mexican War, Polk reaffirmed and extended the Monroe Doctrine in a special message to Congress (see **Monroe Doctrine**). The president said that the doctrine was "our settled policy, that no further European colony or dominion shall, with our consent, be planted or established on any part of the North American Continent." Polk extended the doctrine to cover European interference in the relations among American countries.

Retirement. When Polk had accepted the nomination for president in 1844, he declared he would "enter upon the discharge of the high and solemn duties of the office with the settled purpose of not being a candidate for reelection." He was the first president not to seek reelection. Polk left the nation not only his record of political accomplishment and territory acquired, but also a diary that is an invaluable record of his presidency.

After his successor, Zachary Taylor, was inaugurated, the white-haired Polk returned to his home in Nashville, Tennessee, worn out by four years of hard work. He became ill with cholera and died on June 15, 1849. Polk was buried in the city cemetery and later reburied on the grounds of his estate, "Polk Place." Mrs. Polk lived at Polk Place until her death in 1891 and was buried beside her husband. In 1893, the Polks' remains were moved to a tomb on the grounds of the Tennessee Capitol in Nashville. Sam W. Haynes

Related articles in *World Book* include:

Clay, Henry
Dallas, George Mifflin

Fifty-Four Forty or Fight	Mexico (History)
Manifest destiny	President of the U.S.
Mexican War	Wilmot Proviso

Outline

I. Early life
- A. Childhood
- B. Education

II. Political and public activities
- A. Lawyer and legislator
- B. Polk's family
- C. Congressman
- D. Governor
- E. Election of 1844

III. Polk's administration (1845-1849)
- A. Life in the White House
- B. Tariff reduction
- C. An independent treasury
- D. "Oregon fever"
- E. The Mexican War
- F. "The Polk Doctrine"
- G. Retirement

Questions

What were the four major goals of Polk's administration? How were they accomplished?
How did life in the White House change under the Polks? Why?
Why did Polk refuse to run for reelection?
What regions did the United States acquire during Polk's administration?
Why is Polk considered one of the most successful U.S. presidents?
Why was Polk nicknamed "Young Hickory"?
What happened to make Polk the first "dark horse" presidential candidate?
What was the meaning of "Fifty-Four Forty or Fight!"?
How did Polk extend the Monroe Doctrine?
Why did reformers dislike Polk?

Additional resources

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Haynes, Sam W. *James K. Polk and the Expansionist Impulse.* Longman Pub. Group, 1997.
Leonard, Thomas M. *James K. Polk: A Clear and Unquestionable Destiny.* S R Bks., 2000.
Lillegard, Dee. *James K. Polk.* Children's Pr., 1988. Younger readers.

Polk, *pohk,* **Leonidas,** *lee AHN ih duhs* (1806-1864), an Episcopal bishop, was a Confederate general in the American Civil War. He commanded the defense of the Mississippi River in 1861. Polk fought in the battles at Belmont, Missouri; Shiloh, Tennessee; Perryville, Kentucky; and Murfreesboro, Tennessee. He led a corps at Chickamauga, Georgia, and served in the Atlanta campaign. Polk was killed in action at Pine Mountain, Georgia.

Polk was born on April 10, 1806, in Raleigh, North Carolina. He graduated from the United States Military Academy. In 1827, he left the army to study for the ministry. In 1841, he became the first Protestant Episcopal bishop of Louisiana. Polk helped found the University of the South in Sewanee, Tennessee. Steven E. Woodworth

Poll. See **Election; Public opinion poll.**

Poll tax is a tax levied equally on all the citizens of a community. The amount of the tax is the same for a poor person as it is for a rich one. The term *poll tax* comes from the old English word *poll,* which means *head.* Many people refer to it as a *head tax.* A poll tax is sometimes called a *capitation* tax, from the Latin word *caput,* meaning *head.* Some people object to poll taxes because they feel taxes should be based only on income and property. However, many economists favor poll taxes because they believe that such taxes do not lessen a person's incentive to earn more money.

The United States has never levied a national poll tax. But in the past, laws in several states required that a citizen who did not pay the poll tax could not vote. Amendment 24 to the United States Constitution, ratified in 1964, made it illegal for a state to use payment of taxes as a voting requirement in national elections. In 1966, the Supreme Court of the United States declared poll taxes unconstitutional if they are used as a requirement for voting in state and local elections. The court held that such taxes violated the equal protection of the law guaranteed by Amendment 14 to the United States Constitution. Vito Tanzi

See also **Constitution of the United States** (Amendment 24).

Pollaiuolo, *POH ly WOH loh,* **Antonio del** (about 1432-1498), was an Italian sculptor and painter. The ways in which he portrayed the human body in his sculpture and painting greatly influenced the work of the Renaissance artists Andrea del Verrocchio, Leonardo da Vinci, and Michelangelo.

Pollaiuolo was born in Florence. About 1460, he completed three large paintings of the deeds of Hercules. These paintings have not survived, but two small versions show figures struggling furiously. He reworked the subject of *Hercules and Antaeus* in a small bronze group that is so powerful in its expressive use of anatomy that viewers feel they are participating in the action. Pollaiuolo lived in Rome from about 1483 until his death, designing and casting the bronze tombs of Popes Sixtus IV and Innocent VIII. Roger Ward

See also **Renaissance** (picture: Mythological subjects).

Pollen consists of tiny grains that are produced in the male organs of flowering and cone-bearing plants. Seeds develop after pollen is transferred from the male part of a plant to the female part. This transfer of pollen is called pollination.

Most pollination is carried out by birds, insects, and the wind. Most flowers pollinated by birds and insects have colorful blossoms and an odor that attracts the animals. When birds and insects come into contact with a flower, pollen clings to their bodies, and they then carry the grains to other flowers. The wind blows pollen from one flower or cone to another. Most flowers pollinated by the wind have neither bright colors nor a fragrant odor.

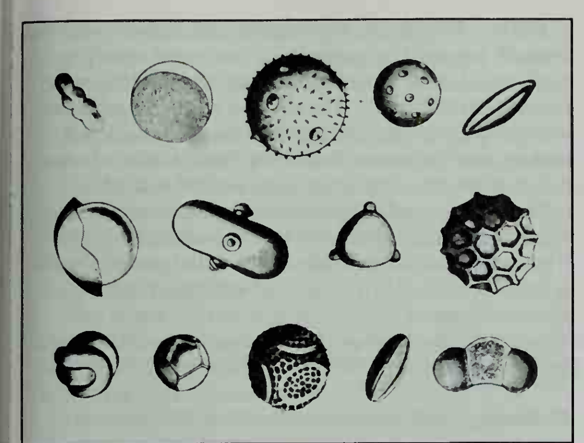
A flowering plant produces pollen in its *stamens,* the male parts of a flower. After pollination, seed development occurs in the female part, called the *pistil.* A cone-bearing plant produces pollen in its *male pollen cones.* Pollination occurs when the wind carries pollen from the male pollen cones to the *female seed cones.*

Many people are allergic to pollen. Large amounts of pollen in the air cause them to develop hay fever. This allergy results in headaches, red and itching eyes, a runny nose, and sneezing. Ragweed pollen is the most common cause of hay fever in the United States.

Fossilized pollen grains are often preserved in sediments from lakes and bogs. By studying these grains, scientists can learn much about the plant life and climate of earlier ages.

Pollen grains

Pollen grains vary in shape, size, and surface features. These variations make the grains of each species of


Brooklyn Botanic Garden

Pollen grains are so small that they look like tiny specks to the unaided eye. But they have definite shapes and surface patterns depending on the kind of plant that produced them.

plant different. Most pollen grains are round or oblong and range from 15 micrometers to more than 200 micrometers wide. (About 25,000 micrometers equal 1 inch.) Every pollen grain has an outer shell, which may be smooth or wrinkled, or covered with spines or knobs. This shell prevents the inner cells from becoming dry.

Such plants as corn, wheat, and pine trees, which are pollinated by wind, produce huge amounts of pollen. A corn plant can produce more than 18 million grains. But some plants that are pollinated by birds and insects produce only a few thousand grains.

Most pollen grains live only several days or weeks after being released. However, the cells of date palm pollen live for as long as a year.

Methods of pollination

There are two methods of pollination, *cross-pollination* and *self-pollination.* Cross-pollination is the transfer of pollen from the stamens of one flower to the pistil of a flower of another plant. Self-pollination occurs when pollen is transferred from the stamens of one flower to the pistil of the same flower, or to another flower on the same plant.

Cross-pollination is the most common method. For seeds to develop, cross-pollination must occur between flowers of the same or closely related species.

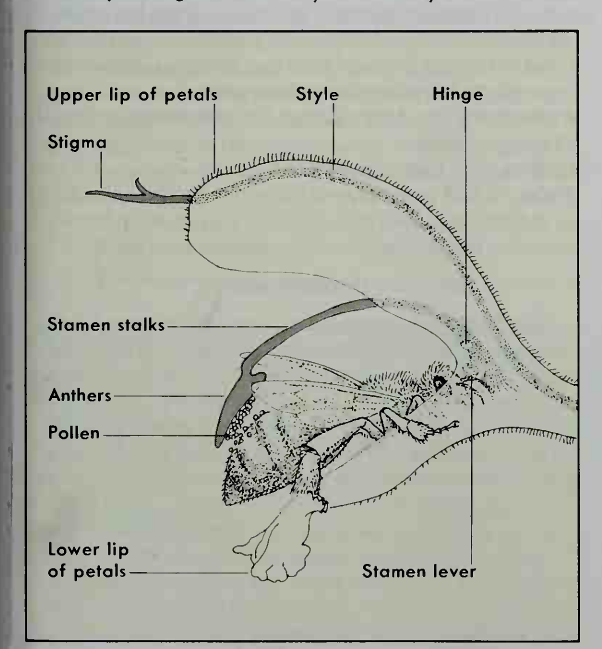
Honey bees carry out more cross-pollination than any other kind of insect. They make honey from nectar and use pollen for food. Honey bees collect pollen in small cavities on their hind legs and carry it back to the hive. However, some pollen clings to their bodies and is carried to other flowers. Other insects that carry pollen include ants, beetles, butterflies, and moths.

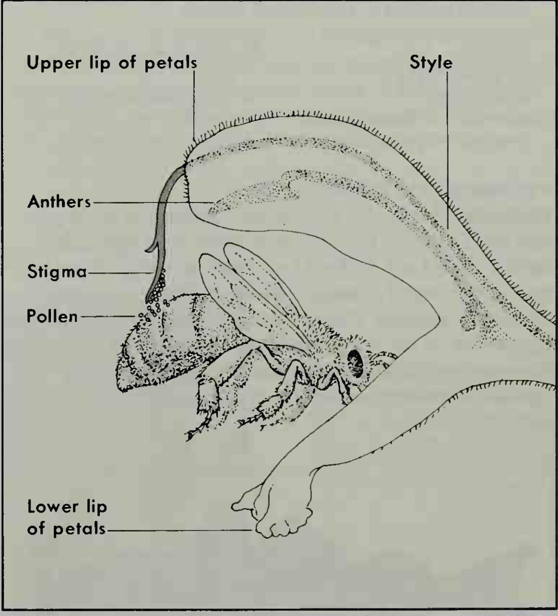
Among birds, hummingbirds are the most important pollinators. They insert their long, thin beak into flowers and drink the nectar. Pollen sticks to the beak and is carried to the pistils of other flowers.

The wind pollinates many plants, including birches, corn, grasses, cattails, oaks, and ragweeds. It may carry pollen grains 100 miles (160 kilometers) or farther.

Botanists have used artificial cross-pollination to create new varieties of corn, cotton, wheat, and other plants. They use special brushes to transfer pollen from one plant to another.

Self-pollination. Many plants, including beans, cotton, oats, peas, and wheat, normally pollinate them-





WORLD BOOK diagrams by Marion Pahl

Pollination of the European sage is a complicated operation. When a bee enters a young flower, *left,* the insect's head hits the stamen lever. This hinged lever causes the anthers to swing downward, depositing pollen on the bee's back. If the bee goes later to an older flower, *right,* pollination will occur. In the older flower, the stigma droops down to receive pollen. As the bee enters the flower, the pollen is brushed off its back and sticks to the stigma.

selves. Certain cross-pollinating plants, such as pansies and some violets, can also self-pollinate.

The growth process and the structure of some flowers prevent self-pollination. In plants called crane's-bills and spiderworts, for example, the stamens ripen earlier than the pistils. Therefore, the pollen is shed from the stamens before the pistils of the same plant become ripe. Willow trees and other species have *imperfect flowers*. In such species, each plant bears flowers with either stamens or pistils, but not both.

Fertilization

All flowering and cone-bearing plants produce seeds through *fertilization*. In fertilization, which occurs after pollination, a male sperm cell unites with a female egg cell.

In flowering plants, the egg cells develop in the *ovary*, the base of the pistil. The sperm cells are produced by the pollen grains. After pollination, a pollen grain swells as it absorbs water, sugar, and other materials from the *stigma*, the top of the pistil. The pollen then *germinates*—that is, it grows a tube downward to the *ovary*, where one or more *ovules* are located. The ovules are the structures that contain the egg cells. After the pollen tube reaches an ovule, it releases two sperm. One sperm fertilizes an egg cell. The second sperm fertilizes two female structures called the *polar nuclei*. The union of the second sperm with the polar nuclei produces the *endosperm*, the food-storage tissue of the new seed. Only flowering plants form seeds through such *double fertilization*.

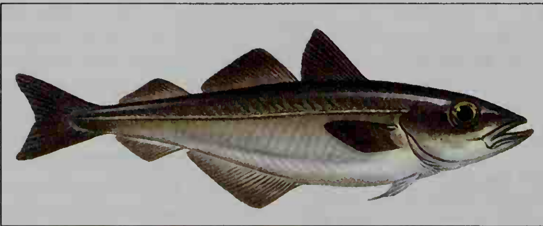
In cone-bearing plants, the sperm and egg cells develop in the male cones and female cones. After pollination, one of the two sperm fertilizes an egg. The other sperm disintegrates. Richard C. Keating

Related articles in *World Book* include:

Climate (Determining past climates)
Corn (How the plant reproduces)
Flower (Role of flowers in reproduction; pictures)
Hay fever
Plant (Sexual reproduction)
Tree (picture: How most trees reproduce)

Polliwog. See Tadpole.

Pollock, *PAHL uhk,* also spelled *pollack,* is an important food fish that belongs to the family of fish called codfish (see **Cod**). Pollocks account for a significant portion of the world's annual fish catch. There are three species of pollock. The *walleye pollock,* also called *Alaska pollock,* is the most important commercial species. It lives in the northern Pacific Ocean. The other two species of pollock are found in the northern Atlantic Ocean.



WORLD BOOK illustration by Colin Newman, Bernard Thornton Artists

Pollock is a popular food fish.

Pollock differ from other codfish since their lower jaw extends beyond the upper jaw. The Atlantic species grow to 3 ½ feet (1 meter) long and can weigh up to 66 pounds (30 kilograms). The walleye pollock is smaller, weighing up to 11 pounds (5 kilograms). Pollock live mainly near the ocean floor. They feed chiefly on small fish and they also eat other small aquatic animals.

The walleye pollock is sold fresh or frozen. It is also *filleted* (deboned) and made into fish sticks. In addition, it is used to prepare a fish mixture called *surimi,* which is used in making fish cakes and artificial crab meat.

Vidar G. Wespestad

Scientific classification. Pollock are members of the codfish family, Gadidae. The scientific name for the walleye pollock is *Theragra chalcogramma.*

Pollock, *PAHL uhk,* **Jackson** (1912-1956), was an American artist who had an important influence on modern painting as an important figure in the abstract expressionist movement. He devised a painting technique in which he dripped paint onto his huge canvases. The drippings formed sweeping, rhythmic patterns of line that seem to weave across the surface.

Pollock painted with his canvas on the floor. He said, "I feel nearer, more a part of the painting, since this way I can walk around it, work from the four sides, and literally be *in* the painting." The attitude that the working artist is *in* the painting is generally considered characteristic of abstract expressionism.

Pollock was born in Cody, Wyoming. From 1929 to 1931, he studied with Thomas Hart Benton at the Art Students League in New York City. He worked in the Federal Art Project from 1938 to 1942. Pollock painted in an expressionistic symbolic style before moving to pure abstraction in the late 1940's. In his last works, he returned to certain figurative references from his earlier works. He combined them with the loose forms developed in his technique of pouring, dripping, and working with sticks rather than with brushes. Dore Ashton

Pollution. See **Air pollution; Environmental pollution; Water pollution.**

Pollux. See **Castor and Pollux.**

Polo is a ball game played on horseback on an outdoor or indoor field. Two teams of four players each try to drive the ball through their opponents' goal posts.

Outdoor polo

The field and equipment. A regulation polo field is 300 yards (274 meters) long and 200 yards (183 meters) wide. The field is only 160 yards (146 meters) wide if the sidelines are boarded. The sideboards are 11 inches (28 centimeters) high. The goal posts are made of light material so that they will break easily if a horse runs into them. The posts are spaced 24 feet (7.3 meters) apart at opposite ends of the field.

Polo players use plastic or wooden balls that are 3 to 3 ½ inches (7.6 to 8.9 centimeters) in diameter. The balls weigh 3 ½ to 4 ½ ounces (99 to 128 grams). The players carry cane or rattan mallets from 48 to 54 inches (122 to 137 centimeters) long. At one end of the mallet is a horizontal piece of hardwood, and at the other end, a lightweight strap made of *web* (a strong cloth material). The strap fastens to the thumb. A player's equipment usually consists of boots, white breeches, knee guards, whip, spurs, mallet, helmet, and a jersey.

The horses. Polo horses, or *polo ponies,* are not of any special breed or size. Thoroughbreds and three-quarter thoroughbreds are generally considered the most acceptable.

It takes six months to a year to train a polo pony. It must be able to stop quickly, and to turn, twist, and resume stride with little loss of speed. Most difficult of all, the horse must have the courage to bump into another horse upon the command of its rider. The horse's equipment consists of saddle, bridle, bit, and leg boots or bandages.

The game. At the start, each team is stationed in the center of the field to defend its respective goal. The first two riders play *forward* (offensively) while the third and fourth play *back* (defensively).

Tournament rules dictate whether there are four or six *chukkers* (periods). Each chukker is 7 minutes long. Four-minute intervals are allowed between chukkers for the players to change horses. The half-time intermission is ten minutes.

Games are played on the *handicap basis,* except for the U.S. Open tournament. Polo players have handicaps ranging from −2 to 10. The best players have the highest handicaps. The handicaps of each team's members are added to make sure the team's total handicap does not exceed the limit set for the tournament. If it does exceed the limit, the team cannot play in the tournament. On the handicap basis, the total team handicaps may count in the scoring. For example, if team *A* has a handicap of 20 and team *B* of 17, the game starts with a score of 3-0 in favor of team *B*.



Leo de Wys

A polo match is a contest between two teams of expert horsemen. Each team attempts to score goals by hitting a ball through its opponent's goal posts with long-handled mallets.

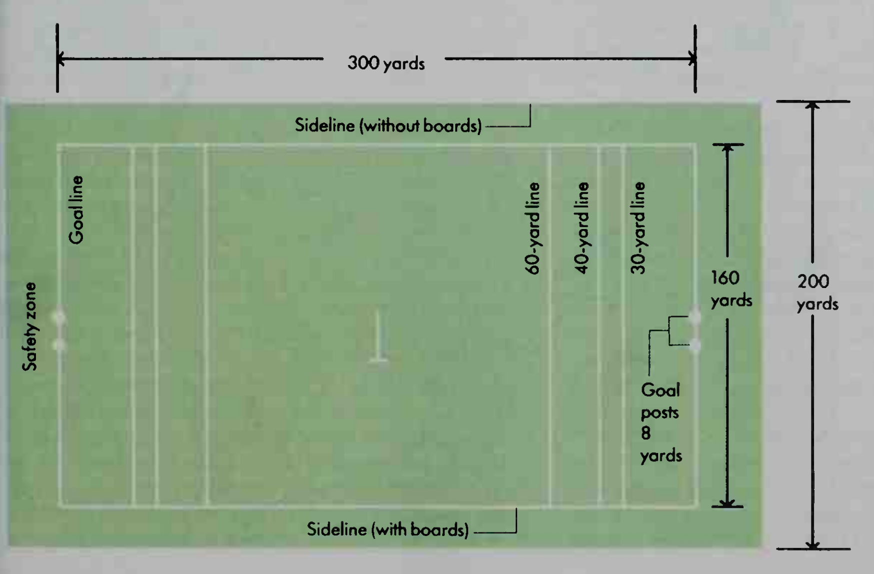
Other kinds of polo

Arena polo is played on indoor fields of sand, clay, or dirt. Each team has three players. The rules are similar for both outdoor and arena polo except for the size of the field, the type of ball used, and the length of the game. The size of the field depends on the size of the arena. Major indoor arenas are 100 yards (91 meters) long and 50 yards (46 meters) wide. They have goals 10 feet (3 meters) wide and 15 feet (4.6 meters) high marked on opposite ends of the field. The game has four $7\frac{1}{2}$-minute periods. The ball is inflated and is from $12\frac{1}{2}$ to 15 inches (32 to 38 centimeters) in circumference.

Indoor-outdoor polo has won increased popularity in recent years. It is played outdoors, but the players use the same rules that they do in arena polo. The field is 100 yards (91 meters) long and 50 yards (46 meters) wide, and is enclosed by a board fence 4 to $4\frac{1}{2}$ feet (1.2 to 1.4 meters) high. The indoor-outdoor version of polo is popular wherever there is warm weather and a dry climate. Fewer horses are needed for this type of polo than for outdoor polo.

History

Polo may have originated in Persia, now Iran, about 4,000 years ago. The modern game had its beginning in 1862 at Punjab, India, when a group of British officers copied the sport from some tribal horsemen. The game was introduced in England in 1869.



An outdoor polo field is 300 yards (274 meters) long and 200 yards (183 meters) wide. However, if the sidelines are boarded, then the field is only 160 yards (146 meters) wide.

WORLD BOOK diagram

In Egypt, India, and England, polo was played as an outdoor sport. But the first polo game in America was played indoors at Dickel's Riding Academy in New York City in 1876. Polo remained an indoor sport in the United States until 1880, when it became equally popular as an outdoor game. Teams from England and the United States played the first international polo series at Newport, R.I., in 1886. Tommy Hitchcock, Jr., and Cecil Smith are generally considered the greatest United States polo players of all time.

Critically reviewed by the United States Polo Association

See also **Water polo**.

Polo, Marco (1254-1324?), an Italian trader and traveler, became famous for his travels in central Asia and China. He wrote a book that gave Europeans some of their earliest information about China, which was then called *Cathay.*

Early life. Marco Polo was born in Venice. His father, Nicolò Polo, was a merchant. Nicolò and his brother, Maffeo Polo, had left on a trading mission shortly before Marco's birth. Marco's mother died when he was a young boy, and an aunt and uncle raised him. They trained him to be a merchant. Besides reading, writing, and arithmetic, Marco learned about using foreign money, judging products, and handling cargo ships.

Nicolò and Maffeo Polo returned to Venice in 1269. The brothers had traveled to eastern Asia and had met the Mongol ruler Kublai Khan in China. The Khan had invited them to visit China again, and so they prepared for another expedition—one that would include Marco.

Journey to China. In 1271, Marco Polo—then 17 years old—and his father and uncle sailed from Venice to Acre (now Akko), a port in Palestine. From there, they rode camels to the Persian port of Hormuz, which is now in Iran. The Polos wanted to sail to China from Hormuz, but the ships available there did not seem seaworthy. The travelers continued by camel across the deserts and mountains of Asia. More than three years after leaving Venice, they reached Kublai Khan's summer palace in Shangdu (also spelled Shang-tu), near what is now Kalgan. The Khan gave the Polos a hearty welcome.

Kublai Khan valued the experience and knowledge of his guests. Marco knew four languages, and the Khan sent him on many official tours of the kingdom. These tours took Marco to China's southern and eastern provinces and as far south as Burma. Marco served as a government official in the Chinese city of Yangzhou (also spelled Yang-chou) for three years.

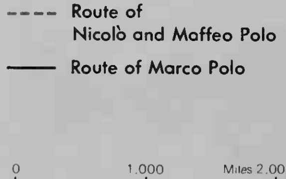
As time passed, the Polos began to worry about returning home safely. Kublai Khan did not want the Polos to leave China, but they believed that if Kublai Khan were to die before they left China, his enemies might capture them. Finally, in 1292, their chance came. The Khan's great-nephew, the Mongol ruler of Persia, had sent representatives to China to bring him back a bride. The representatives asked the Polos to accompany them on their return to Persia. Kublai Khan reluctantly agreed. That same year, the Polos and a fleet of 14 junks sailed from Zaitun (now Quanzhou, also spelled Ch'üan-chou), a port in southern China.

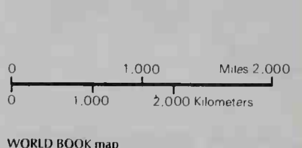
The fleet sailed to what is now Singapore. From there, it traveled north of Sumatra and then around the southern tip of India. The Polos crossed the Arabian Sea to Hormuz. There, they left the wedding party and traveled overland to the Turkish port of Trebizond (now Trabzon). They sailed to Constantinople and from there to Venice, arriving in 1295. Their journey to China and back probably totaled nearly 15,000 miles (24,100 kilometers). The men had been gone for 24 years.

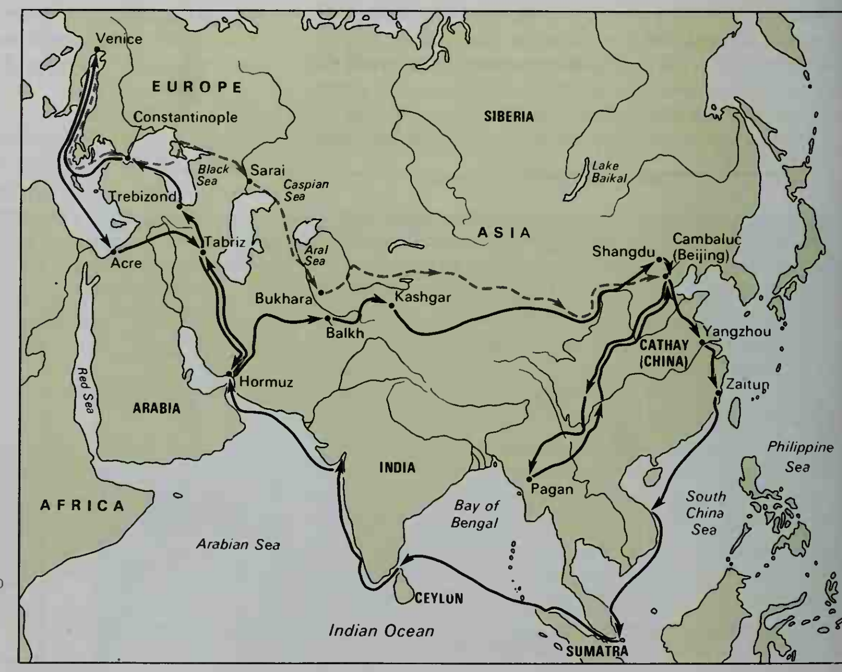
Later life. The Polos returned from China with many riches. Kublai Khan had given them ivory, jade, jewels, porcelain, silk, and other treasures. When they arrived

The travels of Marco Polo

Marco Polo's father and uncle traveled from Venice to Asia in the mid-1200's. Their route is shown on the map as a dashed line. The Polos, this time accompanied by Marco, set out again for Cathay in 1271 and reached Shangdu in 1274. Marco Polo's travels took him as far as Pagan in what is now Burma. The three Polos stayed in Cathay until 1292 and returned to Venice in 1295. Marco's route is shown as a solid line on the map.







WORLD BOOK map

in Venice, the city was at war with Genoa, its long-time rival. In 1296, the Genoese captured and jailed Marco Polo. Historians do not know the details of his capture. In prison, Polo decided to write about his travels. Aided by his notes, he dictated the story to a popular writer, Rustichello of Pisa. Rustichello translated it into Old French, the literary language of Italy at the time. The book was completed in 1298.

In his book, called *Description of the World,* Polo told about Kublai Khan's prosperous, advanced empire. He described the Khan's postal system, which consisted of a vast network of courier stations. Riders on horseback relayed messages from one station to another.

Polo commented on many Chinese customs, such as the mining and use of coal as fuel. Coal had not yet been used in Europe. Polo called coal *black stones.* He also marveled at the Chinese use of paper money, which bore the seal of the emperor. At that time, Europeans traded with heavy coins made of copper, gold, or lead.

Printing had not yet been invented in Europe, and so scholars copied Polo's book by hand. *Description of the World* was widely read in Europe and may have influenced many explorers. It affected Christopher Columbus's estimate of the distance between Spain and Asia.

Description of the World stimulated European interest in Asia and helped bring to Europe such Chinese inventions as papermaking and printing. Genoa and Venice made peace in 1299. Polo was freed and returned to trading in Venice. John Parker

See also **Exploration** (European exploration); **Kublai Khan.**

Additional resources

Larner, John. *Marco Polo and the Discovery of the World.* Yale, 1999.
Macdonald, Fiona. *Marco Polo.* Watts, 1998. Younger Readers.

Polonium, *puh LOH nee uhm,* is a rare, radioactive metallic element. The French physicists Marie and Pierre Curie discovered it in 1898. They named the element in honor of Poland, the country of Marie Curie's birth. Polonium occurs naturally in the uranium ore pitchblende. But most polonium is made artificially by bombarding bismuth, a brittle metal, with neutrons. Scientists use polonium chiefly for nuclear research.

Polonium has the chemical symbol Po. Its atomic number is 84. It melts at 254 °C and boils at 962 °C. Polonium has 27 known isotopes—more than any other element. All of them are radioactive. Its most stable isotope has a mass number of 209 and a half-life of 103 years. During radioactive decay, polonium changes into lead by giving off alpha particles. Raymond E. Davis

See also **Element, Chemical** (tables); **Isotope.**

Polyandry. See Polygamy.

Polychlorinated biphenyl (PCB), *PAHL ee KLAWR uh NAY tihd by FEHN uhl,* is any of a group of synthetic compounds formed by substituting atoms of chlorine (chemical symbol, Cl) for atoms of hydrogen (H) in a compound called *biphenyl* ($C_6H_5C_6H_5$). A PCB molecule may have from 1 to 10 chlorine atoms.

PCB's once were widely used in the United States in manufactured products. In 1979, however, the United States government prohibited the production of PCB's because of concerns about the effects of PCB's on people. Scientific studies had shown that high concentrations of PCB's may cause birth defects, cancer, liver damage, and nerve disorders. Manufacturers used PCB's in such products as paints and adhesives and in fluids for lubricating industrial machinery. PCB's also were used as insulators in transformers, capacitors, and other electrical equipment. H. Stephen Stoker

Polyester is any of a certain group of widely used plastics materials. One of the main polyesters, *polyethylene terepthalate* (PET), can be spun into fiber, *extruded* (pushed through an opening) to make film, or combined with other materials and molded into plastic parts. PET is a *thermoplastic*—that is, it softens and melts at high temperatures. Polycarbonates are a major group of thermoplastic polyesters (see **Plastics** [Types of plastics]).

Polyesters are synthetic *polymers.* A polymer is a long, chainlike molecule. The "links" are repeating patterns of simple groups of atoms called *monomers.* In most polyesters, the monomers connect to each other by ester groups, units made of one carbon atom and two oxygen atoms.

PET fiber is one of the most widely produced synthetic fibers. It appears in such products as tire cords and clothing. It is strong and flexible, and it resists wrinkling and mildew. Much PET fiber is sold under the name *Dacron,* a registered trademark of the DuPont Company. Uses of PET film include magnetic tapes and shrink wrap. PET is also used to make plastic soft drink bottles, which, like PET film, are clear and tough, and resist water and chemicals.

Other important polyesters are the *unsaturated polyesters.* The monomers in these materials contain *unsaturated acids,* which are hydrocarbon acids with two carbon atoms joined by a double bond (see **Hydrogenation**). Manufacturers use these polymers to make *thermosetting plastics,* which do not soften when heated. Polyester "thermosets" can be combined with *fiberglass* (glass threads) to make a strong rigid material used for automobile body parts, boats, and bowling balls.

Polyester thermoplastics are easy to recycle. The thermosetting materials are difficult to recycle, but can be ground into powders and used as fillers.

Researchers discovered the chemistry of polyesters in the 1930's. In the 1940's, the aircraft industry began to use unsaturated polyesters. In the 1950's, PET fiber became a major product. Marvis E. Hartman

Polyethylene, *PAHL ee EHTH uh leen,* is a major *synthetic polymer,* an essential ingredient of plastics. Polyethylene plastic products include milk jugs, oil bottles, and plastic bags. About a third of all synthetic polymers produced in the United States are polyethylenes.

There are three main types of polyethylene: high density polyethylene (HDPE), low density polyethylene (LDPE), and linear low density polyethylene (LLDPE). HDPE is the toughest and most rigid type. Manufacturers form it into such products as bottles and jugs. LDPE and LLDPE are relatively soft and flexible. Manufacturers produce them as thin films. One use of LDPE is as bread bags. Garbage bags are made of LLDPE, which is stronger than LDPE.

A polymer is a long, chainlike molecule. The "links" are repeating patterns of simple groups of atoms called *monomers.* Polyethylene is made from *ethylene* monomers, each consisting of two carbon atoms and four hydrogen atoms. The chemical formula of polyethylene is

$(C_2H_4)_n$, where *n* is the number of monomers.

Manufacturers make polyethylene by mixing a solution of ethylene gas with a *catalyst,* a substance that speeds a chemical reaction without being used up by the reaction. Many polyethylene plastics contain special ingredients, such as colorings and a substance that prevents film from sticking to itself. Polyethylene melts at 230 to 300 °F (110 to 150 °C). It can be melted and reformed again and again, so it is easy to recycle. Imperial Chemical Industries (ICI) of the United Kingdom first produced polyethylene in 1939. Marvis E. Hartman

See also **Plastics** (Diagram: How plastic resins are made); **Polymer.**

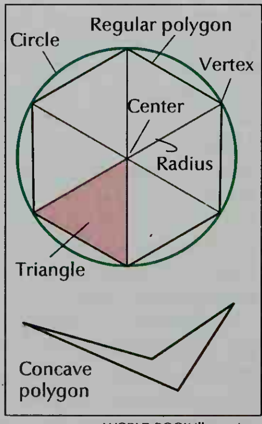
Polygamy, *puh LIHG uh mee,* can refer either to a system in which a man is married to more than one woman at the same time, or, less commonly, in which a woman is married to more than one man at the same time. The word *polygamy* comes from two Greek words meaning *many marriages.* Polygyny is a more specific term for the practice of marrying more than one wife. *Polyandry* refers to marrying more than one husband.

Polygyny is much more common than polyandry. Many peoples have practiced polygyny, and some still do, especially in Asia and Africa. The Muslim religion permits marriage between a man and as many as four wives, and the Hindu religion sets no limit on the number of women who may be married to one man. When more than one woman is married to the same man, each wife usually has her own house. The time the husband spends with each wife is usually strictly prescribed. Polygyny was once customary in China and Turkey, but those countries now have laws against it. In the United States, Mormons practiced polygyny until their church made it illegal in 1890. The U.S. Congress had passed a law forbidding polygyny in 1862. But some U.S. families still practice polygyny in the United States, especially in the West. Many of them consider themselves to be following the original Mormon customs.

Polyandry was permitted among the Todas of India and the Inuit (formerly called Eskimos) of the Arctic. Some groups in Tibet still practice it. Jennie Keith

See also **Marriage; Mormons** (Church doctrines).

Polygon, *PAHL ee gahn,* is a closed plane figure composed of a certain number of straight line segments called sides. For example, a polygon that has three sides is a triangle. A polygon with five sides is a pentagon; with eight sides, an octagon. But there are no special names for polygons with a large number of sides, such as ones with 128 or 3,472 sides.



WORLD BOOK illustrations

The end points of a polygon's sides are called *vertexes* or *vertices.* Two sides—and only two sides—meet at each vertex. Those neighboring sides are known as *adjacent sides.* Where these sides meet, they form an angle inside the polygon. Two sides that are not adjacent do not meet at any point.

A polygon is called *equilateral* if all its sides are equal in length. It is *equiangular* if all its angles are equal. A polygon that is both equilateral and equiangular is a *regular polygon.* A regular polygon is a type of *convex polygon.* A polygon is convex if no side, when extended, enters the polygon. A polygon is *concave* if any side, when extended, enters the polygon.

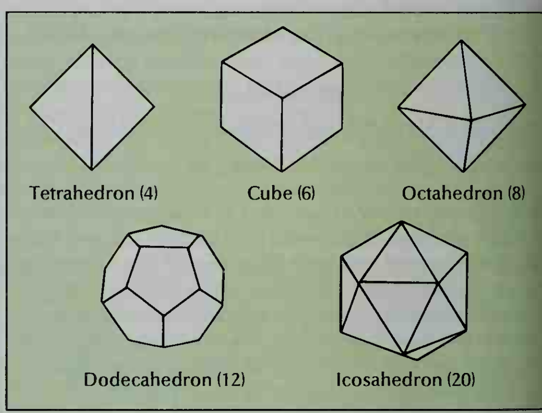
The diagram in this article may help you understand the following three facts about regular polygons: (1) You can draw a circle around a regular polygon so that all of the polygon's vertexes lie on the circle. (2) The center of that circle defines the center of the polygon. (3) Drawing a straight line segment—called a *radius*—from the center of the polygon to each vertex will divide the polygon into identical triangles, one for each side of the polygon.

Deborah Loewenberg Ball and Hyman Bass

See also **Octagon; Pentagon; Triangle.**

Polygraph. See **Lie detector.**

Polyhedron, *PAHL ee HEE druhn,* is a solid figure bounded by four or more flat surfaces called *faces.* Each face of a polyhedron is a polygon. The sides of the polygons form the edges of the polyhedron. The points at which the edges meet are called *vertices.* Examples of polyhedrons include cubes and pyramids. A polyhedron is *convex* if it lies entirely on one side of each of the planes determined by the faces.



WORLD BOOK illustrations

The five regular polyhedrons, with their number of identical faces, are shown here.

A *regular polyhedron,* or *Platonic solid,* is a convex polyhedron in which each face is a *regular polygon* and is identical to all the other faces. A regular polygon has equal sides and equal angles. The five regular polyhedrons are tetrahedrons (4 faces), cubes (6 faces), octahedrons (8 faces), dodecahedrons (12 faces), and icosahedrons (20 faces). John K. Beem

Polymer, *PAHL ih muhr,* is a large molecule formed by the chemical linking of many smaller molecules into a long chain. The small molecular building units are called *monomers.* Monomers are joined into chains by a process of repeated linking known as *polymerization.* A polymer may consist of thousands of monomers. Some polymers occur naturally. Others are synthetic.

Many common and useful substances are polymers. For example, starch and wool are naturally occurring

olymers. Starch is formed by plants from a simple sug-r called *glucose,* and wool is a variety of protein. Nylon nd *polyethylene,* a tough plastic material, are examples f synthetic polymers. Rubber, another polymer, occurs aturally and is also made synthetically.

A chain molecule has a definite length, but, like a iece of string, it can assume a variety of shapes. This ombination of molecular length and flexibility gives olymers many useful and unique properties. For exam-le, rubber and numerous other polymers can be retched to several times their normal length without reaking. The chains simply straighten into more ex-nded shapes. Because of the large size of the mole-ules, polymers do not dissolve easily. They also have igh *viscosity* (resistance to flowing). Marvis E. Hartman

See also **Monomer; Viscosity.**

olymorphism, *PAHL ee MAWR fihz uhm,* is the oc-urrence of three or more distinct types of adults in a pecies. For example, there are three types of adult hon-y bees—queen, worker, and drone. Polymorphism is ommon among insects, jellyfish, bacteria, molds, and rotozoans. Breeds and varieties of domesticated ani-als and plants, as well as sexual differences, are not ex-mples of polymorphism. Lawrence C. Wit

olynesia. See **Pacific Islands.**

olyphony. See **Counterpoint.**

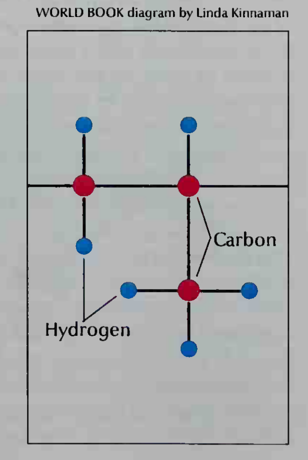
olypropylene, *PAHL ee PROH puh leen,* is a strong, ghtweight, and heat-resistant plastics material. The ma-rial is durable but can be molded into a thin object at bends without breaking. Products made of poly-ropylene include panels for automobile interiors, oatings on telephone wires, carpet fibers, ski apparel, nd containers for such food products as yogurt and argarine.

Polypropylene is a synthetic *polymer.* A polymer is a ng, chainlike molecule. The "links" are repeating pat-rns of simple groups of atoms called *monomers.* Poly-ropylene is made from propylene monomers, each onsisting of three carbon atoms and six hydrogen oms. The chemical formula of polypropylene is $(C_3H_6)_n$, here *n* is the number of monomers. Polypropylene is a *ermoplastic*—that is, it softens and melts at high tem-eratures (see **Plastics** [Types of plastics]).

Manufacturers make polypropylene by mixing propy-ne gas with a *catalyst,* a substance that speeds up a emical reaction without being used up by the reac-tion. They can add pigments to change the color of the material and fillers to make it more difficult to burn or to increase its stiffness. Methods used to shape polypropy-lene products include *extrusion* (pushing melted plastic through an opening), *injection molding* (forcing melted plastic into a mold), and *thermoforming* (using a vacuum to draw hot plastic sheets onto a form).

Giulio Natta, an Italian chemist, developed polypropy-lene in 1954. He shared the 1963 Nobel Prize for Chem-istry with German chemist Karl Ziegler for their work with plastics. Stephen H. Carr

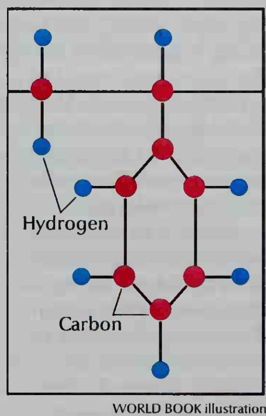
WORLD BOOK diagram by Linda Kinnaman



olypropylene is a synthetic *olymer,* a long, chainlike olecule made of repeating nks" called *monomers.* A olypropylene monomer con-sts of three carbon atoms d six hydrogen atoms.

Polystyrene is a glasslike, lightweight plastics materi-al used in a variety of goods. Products made of poly-styrene include food packaging, insulation, housewares, and automobile parts.

Polystyrene is a synthet-ic *polymer.* A polymer is a long, chainlike molecule. The "links" are repeating patterns of simple groups of atoms called *monomers.* Polystyrene is made from styrene monomers, each consist-ing of eight carbon atoms and eight hydrogen atoms. The chemical for-mula of polystyrene is $(C_8H_8)_n$, where *n* is the number of monomers. Polystyrene is a *thermo-plastic*—that is, it softens and melts at high temper-atures (see **Plastics** [Types of plastics]).



WORLD BOOK illustration

Polystyrene is a synthetic *polymer,* a long, chainlike molecule made up of repeat-ing "links" called *monomers.* A polystyrene monomer con-sists of eight carbon atoms and eight hydrogen atoms.

Polystyrene is fairly strong, easy to work, and inexpensive. A common way to make polystyrene is to heat styrene monomer to about 360 °F (180 °C). Manufacturers produce polystyrene plastics by adding fillers, colorings, and *plasticizers* (chemicals that help soften the material) to the polymer.

A number of methods are used to make products of the plastic. *Extrusion* (pushing melted plastic through an opening) makes a film used in wall coverings. A combi-nation of extrusion and *thermoforming* (using a vacuum to draw hot plastic sheets into a mold) produces food containers and refrigerator parts. *Injection molding* (forcing melted plastic into a mold) creates auto parts and panels for cabinets. *Blow molding* (forcing air and plastic into a mold) produces *polystyrene foam,* a light-weight material containing tiny bubbles of air. This ma-terial is used in ice chests, disposable cups, packaging material, and building insulation.

Polystyrene plastics are difficult to break down into their basic ingredients for recycling. Instead, recyclers grind them into powders that are used as fillers.

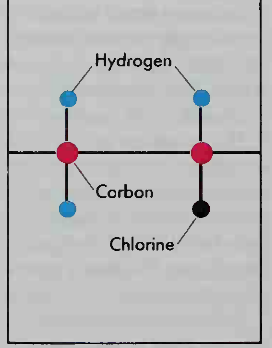
Dow Chemical Company became the first producer of polystyrene in 1930. In the mid-1950's, the company in-troduced polystyrene foam under the registered trade name *Styrofoam.* Marvis E. Hartman

Polytheism, *PAHL ee THEE ihz uhm,* is the idea that the sacred appears in many gods rather than in one God.

The belief in one God is called *monotheism.* Hinduism, for example, is a polytheistic religion. There are three main gods in Hinduism and traditionally 33 million other deities as well. But most Hindus accept the idea that behind them all lies a single spiritual entity, often called *Brahman.* The belief that there is a single high God beyond the gods is also found in many tribal religions. Thus, the line between monotheistic religions and polytheistic religions is not absolute. See also **God; Hinduism; Pantheism; Indian, American** (Religion); **Religion** (Belief in a deity). Mark Juergensmeyer

Polyvinyl chloride (PVC) is a strong, durable plastics material. It mixes easily with lubricants, fillers, and colorings to make plastics with many different properties. There are two basic types of PVC plastics—rigid and flexible. Products made of rigid PVC plastic include bottles, pipes, siding, and window sashes. Flexible PVC plastic products include rainwear, shower curtains, garden hoses, and electrical insulation.

PVC is a synthetic *polymer.* A polymer is a long, chainlike molecule. The "links" are repeating patterns of simple groups of atoms called *monomers.* PVC is made from vinyl chloride monomers, each consisting of two carbon atoms, three hydrogen atoms, and one chlorine atom. The chemical formula of polyvinyl chloride is $(C_2H_3Cl)_n$, where *n* is the number of monomers. PVC is a thermoplastic—that is, it softens and melts at high temperatures (see **Plastics** [Types of plastics]).



WORLD BOOK illustration

Polyvinyl chloride (PVC) is a synthetic *polymer,* a long, chainlike molecule made up of repeating "links" called monomers. A PVC monomer consists of two carbon atoms, three hydrogen atoms, and one chlorine atom.

The most common method of making PVC is *suspension polymerization.* In this process, vinyl chloride monomer—a gas—is fed into water under pressure. There, the monomers link to form the polymer.

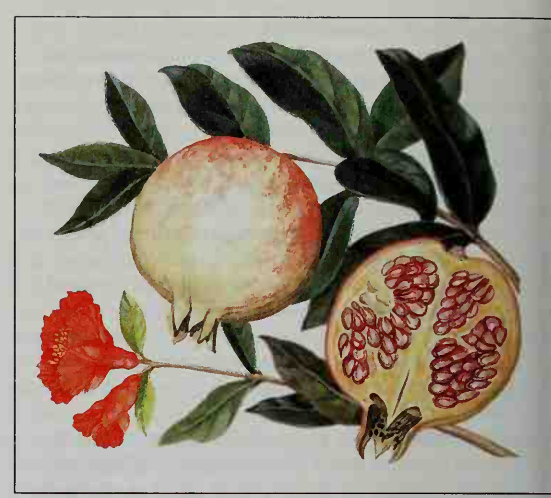
Manufacturers make PVC plastic products by *extrusion* (pushing melted plastic through an opening), *injection molding* (forcing it into a mold), and *calendering* (pressing it between rollers to form sheets).

Vinyl chloride can also form many *copolymers,* polymers made up of more than one monomer. The most important of these contains vinyl chloride and vinyl acetate. This copolymer is used for floor tiles.

Because PVC plastics contain many ingredients, they are difficult to recycle. However, recyclers commonly grind them into powders that are used as fillers.

The first PVC became available in the late 1920's. Production accelerated during World War II (1939-1945), when PVC was used in synthetic rubber and in insulation for electric wires and cables. Marvis E. Hartman

Pomegranate, *PAHM GRAN iht,* is the fruit of a plant raised in warm climates. The plant grows wild in western Asia and northwestern India. It also is grown commercially in the United States and especially thrives in


WORLD BOOK illustration by Kate Lloyd-Jones, Linden Artists Ltd.

Pomegranate fruit has a hard rind. The fruit contains many seeds. The crimson pulp is used to make drinks.

the San Joaquin Valley in central California. The plant is bushlike when wild, but under cultivation it is trained to grow as a small tree. It reaches a height of 15 to 20 feet (4.6 to 6 meters) and bears slender branches. Scarlet flowers grow at the ends of the branches.

The fruit is about the size and shape of a large orange and has a hard rind. It has a deep gold-red color. The fruit contains many seeds. Each seed is inside a layer of crimson pulp which has a pleasant, refreshing taste. The pulp is used to make cooling drinks.

The pomegranate was familiar to the Israelites in Biblical times. A picture of it appeared on the pillars of Solomon's Temple. In classic mythology, Persephone was forced to spend one-third of each year in Hades' underworld kingdom because she had eaten pomegranate seeds while living with Hades (see **Persephone**).

George C. Martin

Scientific classification. Pomegranate plants make up the pomegranate family, Punicaceae. The scientific name for the cultivated pomegranate is *Punica granatum.*

Pomeranian, *PAHM uh RAY nee uhn,* is the name of a breed of small dog. The Pomeranian weighs from 3 to 7 pounds (1.4 to 3.2 kilograms), and has a sharp-nosed foxlike face and small, pointed ears. It may be almost any color from black to white, or even orange. It has a soft, fluffy undercoat and a long, thick topcoat with a frill around its neck. Its tail is also thickly covered with hair, and curls up over its back. The dog has a sharp bark. Pomeranians are related to dogs that originally came from the Arctic Circle. However, they first became well known in Pomerania, a former Prussian province in northern Germany. See also **Dog** (picture: Toy dogs).

Critically reviewed by the American Pomeranian Club

Pomo Indians, *POH moh,* were a group of tribes in northern California. The Pomo originally consisted of 72 small tribes that spoke 7 related languages. Each tribe consisted of from 100 to 2,000 people who lived in extended families. Each extended family was led by a hereditary headman or headwoman. Together, these leaders made up the tribe's decision-making body. Each tribe occupied one or more villages. Pomo territory in-

cluded redwood forests along the Pacific coast and grassy foothills around Clear Lake (see **California** [physical map]). For food, the Pomo gathered acorns, berries, bulbs, and seaweed; caught fish and shellfish; and hunted deer, elk, rabbits, and sea lions.

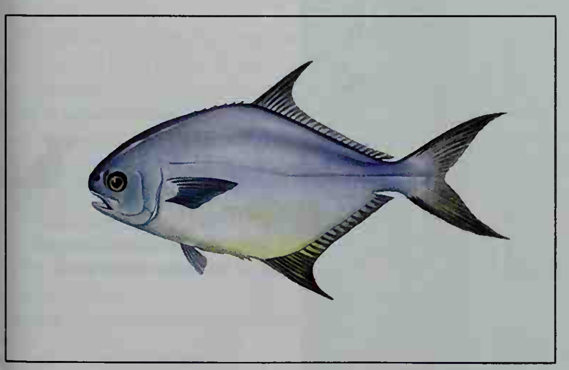
In 1750, there were between 10,000 and 20,000 Pomo Indians. But by 1910, the population had declined to 1,200 as a result of disease and enslavement during Mexican control of the region and as a result of massacres by American settlers. Today, the Pomo live throughout their traditional homeland on reservations and in Ukiah, Santa Rosa, and other towns and cities. Many Pomo work in law, education, and other professional fields. Pomo traditions are kept alive in religious ceremonies, in the creation of basketry art, and in the practice of traditional Pomo medicine. Lee Davis

Pompadour, *PAHM puh DOHR* or *pawn pa DOOR,* **Marquise de,** *mahr KEEZ duh* (1721-1764), was a mistress of King Louis XV of France who played an important part in the politics of Louis's reign. Madame de Pompadour kept her influence long after the king's love for her had cooled. She gave Louis political advice and served as his private secretary. She was blamed for the alliance between France and Austria and France's disastrous involvement in the Seven Years' War (1756-1763). She was also a generous supporter of the arts.

Madame de Pompadour was born in Paris to a middle-class family. Her maiden name was Jeanne-Antoinette Poisson. She received an excellent education and was introduced to high society at the home of Charles-François Le Normant de Tournehem, a wealthy financier. In 1741, she married his nephew Charles-Guillaume Le Normant d'Étoiles. In 1746, she met King Louis at a ball. Louis fell in love with her. She left her husband and went to live in Versailles as Louis's mistress. She received the title Marquise de Pompadour. Maarten Ultee

See also **Louis XV**.

Pompano, *PAHM puh noh,* is the name of a group of valuable food fishes. Several kinds of pompanos are found in the salt waters around North and South America. The *Florida pompano* lives along the Atlantic Coast of the United States and in the seas from the West Indies to Brazil. The Florida pompano is about 1 $\frac{1}{2}$ feet (46 centimeters) long and weighs about 7 pounds (3.2 kilograms). It is bluish above and silvery or slightly golden underneath. The breast is yellowish. The body of the Florida pompano is oblong and flattened from side to side. The flesh of the pompano is highly prized for its rich flavor. Large numbers are caught in nets. Many pompanos are taken on the Florida coasts. The pompano rarely takes a hook.



WORLD BOOK illustration by Colin Newman, Linden Artists Ltd.

The Florida pompano has an oblong body. It is a valuable food fish that lives along the Atlantic Coast.

Another species of pompano is the *palometa,* also called *round pompano.* This fish lives as far north as Cape Cod. It reaches about 1 $\frac{1}{2}$ feet (46 centimeters) in length and weighs about 3 pounds (1.4 kilograms). It is a good food fish. The largest pompano is the *permit,* also called the *great pompano.* The permit grows up to 3 $\frac{3}{4}$ feet (114 centimeters) long and weighs up to 50 pounds (23 kilograms). It lives in the seas from Florida to the West Indies. The permit also is an excellent food fish.

William N. Eschmeyer

Scientific classification. Pompanos belong to the jack family, Carangidae. The scientific name for the Florida pompano is *Trachinotus carolinus.* The palometa is *T. goodei.* The permit is *T. falcatus.*

Pompeii, *pahm PAY* or *pahm PAY ee,* was an ancient city in Italy that disappeared after the eruption of Mount Vesuvius in A.D. 79. For hundreds of years, the city lay buried under cinders, ashes, and stone. Since Pompeii was rediscovered in the 1700's, much has been learned about its history. Each year, excavations in the area around Pompeii bring forth additional bits of ancient art and architecture. Much also has been learned about the everyday life of the ancient Romans and their customs.

Early days. Pompeii was not a remarkable city. But it has become better known than many of the wealthier Roman towns because its ruins were so well preserved. Pompeii lay on a plateau of ancient lava near the Bay of Naples, less than 1 mile (1.6 kilometers) from the foot of Mount Vesuvius. For location, see **Italy** (terrain map).

Scholars have not been able to identify Pompeii's original inhabitants. In the 500's B.C., the area came under the influence of Greek colonies along the coast. A mountain people called the Samnites occupied Pompeii in the 400's B.C. Pompeii remained a relatively unimportant village until the 200's B.C., when the town entered a prosperous period of building and expansion. Pompeii became a Roman community in 91 B.C.

Pompeii was built in the form of an oval about 2 miles (3 kilometers) around. A great wall with seven gates surrounded the city. The streets crossed each other at right angles, and were paved with blocks of lava. Ancient wheel ruts may still be seen in the pavements. In the center of the city was the open square, or forum. It was surrounded by a group of important buildings. The city had a theater, an amphitheater, a gladiators' court, many temples, and three large public baths.

The fair blue skies of Pompeii attracted many wealthy Romans. They built great *villas* (homes) near the Mediterranean shore, where they could enjoy the mild, sunny climate. The Pompeians built their villas with all the conveniences of a town in country surroundings. The large dwellings often consisted of two parts, the master's house and gardens, and the farmer's house with stables, barns, orchards, and fields. Most dwellings were built along the lines of a typical Roman house, with rooms grouped around the *atrium* (reception room). Town houses in Pompeii often had shops bordering the street. Archaeologists believe that most buildings had more than one story. The upper parts of the

buildings may have been constructed partly of wood. They projected out over the street, like French and English houses of the Middle Ages.

Pompeii carried on a prosperous trade in wine, oil, and breadstuffs. The city was a market for the produce of a rich countryside, and its port had widespread connections in the Mediterranean area. Pompeii was also an industrial center and produced such specialties as millstones, fish sauce, perfumes, and cloth. Inhabitants of Pompeii included wealthy landowners, prosperous merchants and manufacturers, shopkeepers, artisans, and slaves.

The eruption of Mount Vesuvius. Earthquakes in A.D. 62 or 63 damaged Pompeii, Naples, and Herculaneum. Statues fell, columns were broken, and some buildings collapsed. Mount Vesuvius rumbled at this time. However, the people did not believe that there would be more danger, and they repaired their cities. During the summer of A.D. 79, Vesuvius erupted suddenly and with great violence. Streams of lava and mud poured into Herculaneum and filled the town and its harbor.

Hot ashes, stones, and cinders rained down on Pompeii. The darkened air was filled with poisonous gas and fumes. The Roman writer Pliny the Younger told in a letter how he led his mother to safety through the fumes and falling stones. His uncle, the writer Pliny the Elder, commanded a fleet that rescued some people. He landed to view the eruption and died on the shore.

The remains of about 2,000 victims out of a population of some 20,000 have been found in excavations at Pompeii. Some of the victims were trapped in their homes and killed by hot ashes. Others breathed the poisonous fumes and died as they fled. Archaeologists find the *shells* (molds) of the bodies preserved in the hardened ash. By carefully pouring plaster into the shells, they can make detailed copies of the individuals, even to the expressions of agony on their faces.

Rather than the lava, showers of hot, wet ashes and cinders sprayed Pompeii. When these ashes and cinders dried, they covered and sealed up much of the city. Only the tops of walls and columns emerged above the waste. Survivors dug out valuables they had left behind and even took statues, marbles, and bronzes. However, later eruptions and erosion erased the last traces of the city.

The eruption of Vesuvius destroyed not only Pompeii but also the nearby cities of Stabiae and Herculaneum (see **Herculaneum**). The eruption changed the entire geography of the Campania region around Pompeii. It turned the Sarno River back from its course and raised the sea beach so there was no way of locating Pompeii, which lay beneath the ash deposits for almost 1,700 years.

Excavations. The buried city was not completely forgotten. Peasants living in the area searched for hidden treasure. They did not excavate openly, but they tunneled into the deposits and reached houses. In the 1500's, workers digging an underground tunnel to change the course of the Sarno River discovered parts of the amphitheater, forum, and a temple. But no one paid much attention to these finds.

In 1748, a peasant was digging in a vineyard and struck a buried wall. His discovery was brought to the attention of authorities in Italy, and soon people began to carry on excavations in the region. At first, the diggers hoped to recover objects that would enrich the museums of the kings of the Two Sicilies. For about 100 years, the search concentrated on important buildings, such as the forum, the amphitheater, the theater, and the larger houses.

After 1860, Giuseppe Fiorelli served as director of the excavations. He instituted the first systematic uncovering of the whole city block by block. In the early 1900's, archaeologists decided not to remove treasures from the city, but to keep them and to restore buildings as much as possible to their original condition. The Italian government has given money for this work.

Remains. Approximately three-fourths of Pompeii has now been uncovered. Visitors may view buildings as they stood almost 2,000 years ago. They may walk in and out of houses and up and down narrow lanes, just as the Pompeians did. They may see the ruins of the ancient public square, with many of the surrounding buildings.

Visitors also may see the old Temple of Jupiter, which was an ancient ruin at the time of the eruption of Vesuvius. They may wander through the old Roman public

Fred M. Dole, FPG



Mount Vesuvius looms in the background over the once-thriving city of Pompeii. The cinders and ashes that buried the city aided in preserving its ruins for almost 2,000 years. About three-fourths of Pompeii has been uncovered.

halls, and admire the temples of Apollo and Fortuna Augusta.

Workers have uncovered a large part of the city wall. The disaster occurred during a local election campaign. Election slogans can still be seen on the walls of houses. Not many valuables have been found. Historians believe that the Pompeians carried many of their possessions with them as they fled from the city. Workers have found bracelets, earrings, gems, and coins. They have also discovered household statues of silver, bronze, and ivory, as well as utensils of metal and glass. Many domestic treasures came to light near Boscoreale, a town near Naples. A large number of Pompeian objects are on display in the National Archaeological Museum at Naples, approximately 13 miles (21 kilometers) from Pompeii. Erich S. Gruen

See also **Vesuvius.**

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Pompey the Great, *PAHM pee* (106-48 B.C.), was an outstanding Roman general and statesman. He was the last obstacle in the rise to power of Julius Caesar.

Pompey was born on Sept. 29, 106 B.C., in Rome, the son of a prominent nobleman. He grew up during the war between Gaius Marius and Lucius Sulla, and in 83 B.C. raised his own army of three legions to help the aristocrat Sulla against the forces of Marius in Italy. Then he wiped out the supporters of Marius in Sicily and Italy.

When Sulla died in 78 B.C., the consul Marcus Lepidus tried to repeal his conservative reforms. But Pompey opposed him and drove him out of Italy. The Senate then sent Pompey to Spain to put down an army of Marius's supporters, who were led by Sertorius. After Sertorius was murdered by his own men, Pompey won an easy victory and returned to Rome in 71 B.C.

The conservative group in Rome did not wish to see Pompey gain further glory, but he was elected consul in 70 B.C. He broke with the conservatives and restored the powers of the tribunes that Sulla had taken away. Through popular support, Pompey was given the task, in 67 B.C., of clearing the Mediterranean Sea of pirates. In 66 B.C., he fought Mithridates of Pontus. Pompey defeated him and conquered eastern Asia Minor, Syria, and Palestine.

The Senate refused to approve his acts in Asia and his promises of land to his troops. So Pompey, Julius Caesar, and Marcus Crassus formed the First Triumvirate in 60 B.C. (see **Triumvirate**). They worked together against the Senate for several years. But Pompey became fearful of Caesar's ever-increasing power, and turned back to the conservatives. In the resulting civil war, Pompey was defeated in Italy and again at Pharsalus in Thessaly in 48 B.C. He escaped to Egypt, but was killed there by order of the Roman-dominated Egyptian government.

Chester G. Starr

Related articles in *World Book* include:

Caesar, Julius
Crassus, Marcus Licinius
Mithridates VI
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Sulla, Lucius Cornelius

Ponce de León, *PAWN say day lay AWN,* or *PAWNS duh LEE awhn,* **Juan,** *hwahn* (1460?-1521), a Spanish explorer, led the first recorded European expedition to reach what is now Florida. He was one of the first explorers to claim part of the North American mainland for Spain. He also conquered what is now Puerto Rico and became its first colonial governor.

According to a popular fable, Ponce de León came to Florida to find a spring called the Fountain of Youth. Old stories said that the waters of the spring were supposed to restore youth and cure sickness. But historians believe that even though Ponce de León may have heard stories about a Fountain of Youth, he was actually interested in finding wealth and new lands that he could govern.

Early life and career. Little is known about Ponce de León's early life. He was born in Santervás de Campos, near the Spanish town of Palencia. He came from a noble family and served as a page in the Spanish court.

Ponce de León reportedly fought in the long Spanish campaign that in 1492 finally drove the *Moors* (Spanish Muslims) out of Granada, their last stronghold in Spain. Most historians believe that he then joined the vast second expedition of the famous explorer Christopher Columbus. The fleet reached Hispaniola, a Spanish island in the West Indies, in 1493. Ponce de León may have then gone back to Spain before returning to Hispaniola in 1502. However, some historians think he did not sail with Columbus but instead may have first come to Hispaniola in 1502.

Ponce de León became a soldier on Hispaniola and led Spanish forces against the Indians in the eastern province of Higüey (now part of the Dominican Republic). He founded the town of Salvaleón, where he built a residence and invested in mining and agricultural enterprises.

In 1508, Ponce de León left Hispaniola to explore the island of San Juan (later renamed Puerto Rico). He discovered gold there and conquered the island. He became governor of the island in 1509.

Florida expeditions. In 1512, King Ferdinand chose Ponce de León to lead an expedition to find and colonize an island called Bimini that the Spaniards thought lay north of Cuba. Ponce de León set sail for Bimini with three ships in 1513. During the voyage, he explored the



Juan Ponce de León in 1513 led the first European expedition to what is now Florida. On the return voyage, Ponce de León probably landed on the north coast of Cuba.

area of the Bahamas. On April 2, 1513, he anchored off the coast of Florida—which he thought was another island—and claimed it for Spain. He probably named the land *La Florida,* because he arrived there during the season of Easter, which the Spaniards called *Pascua Florida* (Easter of the Flowers).

The explorers landed on the east coast of Florida, probably somewhere between present-day St. Augustine and Cape Canaveral. From there, they sailed down the coast, exploring almost the entire eastern shoreline and the southern tip of Florida. They swung around the Florida Keys and then continued partway up Florida's western coast. The Europeans made a temporary base near present-day Fort Myers. They fought several battles in this area with the Calusa Indians.

In May 1513, Ponce de León began a roundabout trip back toward Puerto Rico. He probably stopped on the north coast of Cuba. He sailed by the Bahamas again before he returned to Puerto Rico in the fall.

In 1514, Ponce de León sailed to Spain to press his claims to the Florida territories. King Ferdinand authorized him to colonize Bimini and Florida. But the king also ordered him to stop the attacks by Carib Indians on the Spanish colonies in Puerto Rico. Ponce de León returned to Puerto Rico in 1515 to fight the Carib. However, King Ferdinand died in 1516. Ponce de León soon returned to Spain, where his authorization to make a second expedition to Florida was renewed.

In February 1521, Ponce de León sailed from Puerto Rico with two ships carrying as many as 200 settlers and supplies to establish a colony. They probably landed near the place where the first expedition had encountered the Calusa. The Calusa again put up a stiff resistance against the Spaniards. Ponce de León was wounded, and the colonists decided to turn back. Ponce de León died from his wounds shortly after the fleet reached Cuba. Noble David Cook

See also **Puerto Rico** (picture: Juan Ponce de León).

Pond is a small, quiet body of water that is usually shallow enough for sunlight to reach the bottom. The sunlight enables rooted plants to grow across a pond bottom from shore to shore.

In many regions, ponds have a great variety of animal and plant life. The wind and streams carry in eggs, seeds, and organisms that develop into various forms of life. Pond animals include birds, crayfish, fish, frogs, insects, and turtles. Many ponds have rooted plants that either grow entirely underwater or have parts that extend above the surface. Leafy plants float on the surface. Microscopic organisms also thrive in most ponds.

Pond life. The plant and animal life found in a pond are determined largely by the pond's soil, quality of water, and location. Tropical ponds have different species of plants and animals than ponds in the Arctic, in mountains, or in prairies.

Ponds constantly undergo annual and long-term changes. Water levels normally rise and fall because of rainfall. As water levels change, the type and amount of plant growth also change. As the numbers and types of plants change, some animals may become numerous while others may decline in numbers.

Many natural processes help to maintain ponds. For example, floods and the movement of ice may deepen ponds. Human activities, on the other hand, can seriously harm ponds. For example, the quality of a pond rapidly deteriorates when people fill it with garbage or other wastes.

Kinds of ponds. Ponds may be formed by natural conditions or by human beings. The chief kinds of natural ponds include *alpine ponds, bog ponds, ice-formed ponds, meadow-stream ponds, riverine ponds, sinkhole ponds,* and *tundra ponds.* Many farmers build a *farm pond* for flood control or recreation, or to secure a supply of water.

Alpine ponds are gouged out by glaciers in mountainous regions. Many are located in the Alps in Europe and the Rocky Mountains in the United States.

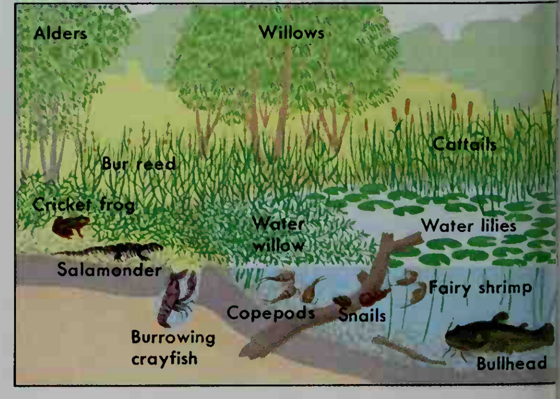
Bog ponds form worldwide, but especially in low-lying places in cooler regions of the Northern Hemisphere. These ponds contain much peat and peat moss. The water of bog ponds has a high acid content.

Ice-formed ponds were created during prehistoric times by sheets of ice that crossed large regions of the world, particularly in the Northern Hemisphere. The scraping action of these sheets caused many basins that became ponds.

The life of a pond The life of a pond changes as the water level changes. In a pond with high water, *left,* plants are less dense and animals that live best in open areas are abundant. When water is low, *right,* plants cover more of the pond surface and animals that thrive in dense plant growth are more common.

WORLD BOOK illustrations by George Suyeoka

Alders
Willows
Swallows
Sandpiper
Heron
Cattails
Bur reed
Mallard
Turtle
Water willow
Water lilies
Water snake
Raccoon
Bullfrog
Chimney crayfish
Clam
Milfoil
Sunfish



Meadow-stream ponds develop where a slowly moving stream widens as it flows over a gently sloping landscape. Most meadow-stream ponds contain abundant life.

Riverine ponds develop where streams have stopped flowing through old channels. These ponds also occur where deposits of soil prevent water from entering channels.

Sinkhole ponds develop in regions that have much limestone beneath the surface of the soil. If underground water dissolves the limestone, the ground sinks and a pond may form. Florida and Indiana have many sinkhole ponds.

Tundra ponds form in regions that have *permafrost* (permanently frozen ground). In such regions, areas of thawed ground may become ponds.

Leigh H. Fredrickson

See also **Marsh**; **Plant** (picture: Plants of a freshwater pond); **Swamp**.

Pond lily. See **Water lily**.

Pontchartrain, Lake. See **Lake Pontchartrain**.

Pontiac, *PAHN tee AK* (1720?-1769), a chief of the Ottawa tribe, was an important American Indian leader during the 1760's. Pontiac tried to unite the tribes of the Great Lakes area and of the Ohio and Mississippi valleys in order to maintain Indian control of those regions.

During the French and Indian War (1754-1763), Pontiac led his tribe in fighting with the French against the British. But he opposed the claims of both sides to the territory west of the Allegheny Mountains. After the British achieved major victories over the French in 1760, they sent a small force to take over the abandoned French forts near the Great Lakes. Pontiac let the British pass through the area. But after he got promises of help from French traders and officers, he made plans with other tribes of the region to attack the posts.

In the spring of 1763, the tribes captured nine British forts in what became known as Pontiac's War. Pontiac led the attack on Fort Pontchartrain, at what is now Detroit. He besieged the post for about five months. However, France sent no help to Pontiac and his forces, and the Indians could not continue the war without more guns and ammunition.



Bettmann Archive

Pontiac

Pontiac was probably born in northern Ohio. He became a priest of a religious group called the Midewiwin, or Grand Medicine, Society. Pontiac agreed with the Indian holy man known as the Delaware Prophet, who preached that Indians should abandon all trade with white people. Pontiac was mysteriously killed at an Indian religious center located in Cahokia, Ill. Rhoda R. Gilman

See also **Indian wars** (Pontiac's War).

Pontiff. See **Pope**.

Pontius Pilate. See **Pilate, Pontius**.

Pontoon bridge is a bridge supported by *pontoons* (flat-bottomed boats), metal cylinders, or other portable floats. A pontoon bridge is sometimes called a *ponton* bridge. A flooring of timber or lightweight metal panels is usually laid across a pontoon bridge.

Pontoon bridges are especially important during wartime. These bridges are built to replace those that have been destroyed by enemy forces. Special pontoon-laying troops bridge streams with mechanical exactness, even under fire. The soldiers lay the flooring, section by section, fastening it securely to the pontoons. Pontoon bridges are usually of limited strength, though sufficient to carry ordinary road vehicles. Soldiers must break step in crossing them to prevent the swaying of the bridge caused by marching in time.

The importance of pontoon-bridge building was shown in Europe during World War II. Retreating troops blew up many bridges across important rivers. Engineers of pursuing armies built pontoon bridges, permitting troops and mechanized equipment to cross the rivers.

In the United States, pontoons have been used for permanent bridges in places where deep water makes pier construction too expensive. Three large concrete floating bridges have been built in Washington. One of these has the longest floating span in North America. This span stretches 7,518 feet (2,291 meters) across Lake Washington. Boyd C. Paulson, Jr.

Pony. See **Horse** (Ponies); **Shetland pony**.

Pony express was a mail delivery service that operated between St. Joseph, Mo., and Sacramento, Calif., in 1860 and 1861. The pony express consisted of relays of men riding fast ponies or horses that carried letters and small packages across a 1,966-mile (3,164-kilometer) trail. These riders could deliver mail to California in 10 days or less, faster than any other mail service of that time. Previously, mail traveled between California and areas east of the Mississippi River only by boat or stagecoach. A one-way delivery between the farthest points took more than three weeks.

Early in 1860, Senator William M. Gwin of California and William H. Russell, a Missouri businessman, agreed to establish an express mail service between St. Joseph and the west coast. St. Joseph then served as the western terminal of the nation's railroad system. Russell's large freighting firm—Russell, Majors, and Waddell—backed the project.

Russell and his associates collected about 400 fast horses, hired approximately 80 riders, and established 190 pony express stations. These stations stood 10 to 15 miles (16 to 24 kilometers) apart. The pony express route ran along the Platte River in what is now Nebraska, to South Pass and Fort Bridger, both now in Wyoming. Then it turned south to the Great Salt Lake. South of Salt Lake City, it headed west across the salt desert to the Sierra Nevada. The pony express began its first run on April 3, 1860. At first, it charged $5 to send half an ounce (14 grams) of mail. The rate later fell to $1 for half an ounce.

Only young, lightweight men served as pony express riders. Many of them were teen-agers. A day's work consisted of a trip of 75 miles (121 kilometers) or more. The rider mounted a fresh horse at each station along the trail. He ended his workday when he reached a *home station,* where another rider took his place. Pony express riders were paid from $100 to $150 a month.



Oil painting on canvas (1900); Thomas Gilcrease Institute of American History and Art, Tulsa, Oklahoma

A pony express rider switches to a fresh mount and begins another step of his dangerous dash across the West. The American artist Frederic Remington captured this scene in his painting *The Coming and Going of the Pony Express.*

The rider carried mail in a specially designed leather saddlebag. The saddlebag fit over the saddle, and only the rider's weight held it in place. As a result, the rider could change horses in about two minutes.

The pony express typically forwarded mail at a rate of more than 200 miles (321 kilometers) a day. The fastest run between St. Joseph and Sacramento came in March 1861. That month, a copy of President Abraham Lincoln's first address to Congress arrived in Sacramento just 7 days and 17 hours after leaving St. Joseph.

The pony express ran day and night. Riders worked in all kinds of weather and faced the threat of Indian attacks. Most of the riders carried a pair of pistols and a knife. Only one rider in the history of the pony express was killed by Indians.

The transcontinental telegraph ended the major need for the pony express. It opened on Oct. 24, 1861, and the pony express officially closed two days later. Russell's freighting firm lost more than $100,000 on the pony express. Odie B. Faulk

See also **Western frontier life in America** (Communication).

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Poodle, *POO duhl,* is the name of a breed of smart, friendly dogs. The poodle was once used as a hunter and retriever, but it is no longer classed as a sporting dog. The breed originated in Germany during the 1500's. Today, poodles are very popular as pets throughout the world.

Poodles may be white, black, gray, blue, brown, or apricot. Their hair is curly or frizzy, and the coat is usually clipped in any of several styles. The three varieties of poodles are classified by shoulder height. The *toy poodle* is 10 inches (25 centimeters) or under; the *miniature poodle* is between 10 and 15 inches (25 to 38 centimeters); and the *standard poodle* is over 15 inches at the shoulder. Poodles weigh from 3 to 60 pounds (1.4 to 27 kilograms).

Critically reviewed by the American Kennel Club

Pool. See **Billiards.**

Poor Richard's Almanac was an almanac written and published by Benjamin Franklin. The famous American statesman created the almanac early in his career, when he was a printer and publisher in Philadelphia. He issued the almanac for every year from 1733 to 1758.

Franklin wrote the almanac under the name of Richard Saunders, an imaginary astronomer. Like other almanacs of its time, *Poor Richard* included such features as astrological signs, practical advice, jokes, poems, and weather predictions. At first, Richard had little wit or humor. But as he developed, he became a clever spokesman for Franklin's ideas on thrift, duty, hard work, and simplicity. *Poor Richard's Almanac* grew



Can Tif's Poodles (DAG Photo)

The standard poodle is one of three varieties of this popular pet breed. It has a curly coat shown clipped here.

into one of the most popular and influential works printed in colonial America. Franklin published the almanac under his own name. In each edition, Richard offered his readers a number of proverbs. Many of these sayings became famous, including:

"A penny saved is a penny earned."
"God helps them that help themselves."
"Early to bed and early to rise,
Makes a man healthy, wealthy, and wise."

Such proverbs expressed Franklin's philosophy that foresight, wise spending, and plain living are not only good qualities, but also lead to success. This philosophy greatly influenced American thought before and after the Revolutionary War (1775-1783).

Franklin enlarged the almanac for the 1748 edition and called it *Poor Richard Improved.* In the preface to the final edition, published in 1757, he collected many of Richard's proverbs on how to succeed in business and public affairs. The preface, called "The Way to Wealth," was reprinted separately and was widely read in England and France as well as in America. However, this collection of proverbs provides a misleading view of Franklin's wisdom and character because it focuses chiefly on material gain and proper conduct. Many of Franklin's other sayings reveal that he also had a witty and sometimes skeptical mind. Edward W. Clark

See also **Franklin, Benjamin** (Publisher; picture: As an author).

Pop. See **Soft drink.**

Pop art is an art movement that originated in England in the 1950's but became best known in the United States during the 1960's. Many pop artists use common, everyday, "nonartistic" commercial illustrations as the basis of their style or subject matter. Many of the works these artists produce are satirical or playful in intent. However, their uses of forms and themes from mass culture are intended to devalue what they consider to be unnecessarily difficult and private aspects of traditional fine art forms.

Pop artists have no single way of working. Some are fascinated by the bold, simple patterns of commercial illustrations. For example, Andy Warhol made exact painted copies of soup cans, repeating them over and over in the same painting. James Rosenquist and Tom Wesselmann use advertising art as the basis of paintings with their own complex, often humorous and frequently critical designs. Several pop artists have made three-dimensional constructions that resemble and embrace the world of ordinary objects. Stephen C. Foster



Wallraf-Richartz-Museum, Cologne, Germany, Ludwig Collection (Ann Münchow)

Pop art painting, like the comic-strip panel *M-Maybe* (1965) by Roy Lichtenstein, shows the influence of commercial art.

Related articles in *World Book* include:

Dine, Jim
Hockney, David
Johns, Jasper
Lichtenstein, Roy
Oldenburg, Claes
Painting (Pop art: picture)
Rauschenberg, Robert
Rosenquist, James A.
Warhol, Andy

Popcorn is a type of corn that is a popular snack food in the United States. Popcorn has smaller kernels than other types of corn, and the kernels are very hard. Popcorn is a good source of dietary fiber and, when eaten plain, is low in calories.

A popcorn kernel has a hard outer shell that surrounds a soft, moist, starchy center. When a kernel is heated, its moisture turns rapidly to steam. The steam builds up pressure inside the shell until the shell bursts. The steam is quickly released with a small explosion that turns the kernel inside-out. The soft center expands and becomes filled with air. Popcorn pops best when kernels contain about 13.5 per cent moisture. Kernels expand to 30 to 40 times their original size when popped.

Popcorn is probably native to Central America and is one of the oldest forms of corn. American Indians grew popcorn for more than 1,000 years before the arrival of European explorers in the 1400's and 1500's. Indians used popcorn for food, for decoration, and in religious ceremonies. Today, the United States grows nearly all the world's popcorn. Indiana, Nebraska, and Illinois lead the states in popcorn production.

Scientific classification. Popcorn belongs to the grass family, Poaceae or Gramineae. Its scientific name is *Zea mays everta.*

Donald J. Reid

See also **Corn** (Kinds of corn; picture).

Popé, *poh PAY* (? -1688?), was a Pueblo Indian leader. He helped plan and lead a major Pueblo revolt against the Spaniards in what is now New Mexico. Spanish explorers had come to this area about 1540. Through the years, they tried to convert the Indians to Roman Catholicism. They forced the Indians to work for them and to pay taxes with crops. In 1680, Popé helped lead a Pueblo revolt that drove out the Spaniards and kept them from the Indians' land for 12 years.

After the revolt, Popé became the leader of several Tewa Pueblo villages. He tried to remove all traces of Spanish influence from Pueblo life. But Popé often used harsh punishments to enforce his rule. In 1688, the villages he controlled forced him from power. Popé died shortly after regaining the leadership of several Pueblo villages later that year.

Popé was born in the pueblo of San Juan, near what is now Santa Fe, N. Mex. His Indian name was *Po-ṕng,* which means Pumpkin Mountain. Joe S. Sando

See also **Indian wars** (The Pueblo Revolt).



UPI/Bettmann Newsphotos

The pope is the spiritual leader of millions of Roman Catholics throughout the world. He also rules Vatican City, an independent country within the city of Rome. Each Christmas Day, thousands of people gather in St. Peter's Square in Vatican City, *shown here,* to receive the pope's blessing.

Pope

Pope is the head of the Roman Catholic Church. The church regards the pope as its visible head and Jesus Christ as its invisible and supreme head. Roman Catholics believe that Jesus established the office of pope when He said to the apostle Simon, who was also called Peter:

> And I say also unto thee, That thou art Peter, and upon this rock I will build my church; and the gates of hell shall not prevail against it (Matt. 16:18).

Except for brief periods of vacancy, there has been an unbroken line of popes beginning with Peter. John Paul II, who became pope in 1978, is generally considered the 264th pope.

The word *pope* comes from the Greek word *pappas,* which is a child's name for its father. The pope is also called the *pontiff,* from the Latin word *pontifex,* a term used for a member of the council of priests in ancient Rome.

The word *papacy* refers to the office of the pope. It is also used for the government of the Roman Catholic Church with the pope as supreme head. The papacy is also called the *Holy See* or *Apostolic See. See* is a term for the official home of a bishop. *Holy See* is especially used as a term for the papacy when referring to its functions and *jurisdiction* (authority).

In the early history of the church, bishops in general were often called pope. Beginning in the early 500's, the title in the Western church came to be used exclusively for the bishop of Rome. According to tradition, Peter traveled to Rome and became the city's first bishop, giving special status to Rome and to its office of bishop. The pope lives in the Vatican Palace in Vatican City, an independent country that is located within the city of Rome.

The pope is elected for life. He can resign, but he cannot be *deposed* (forcibly removed from office). Officially, any practicing Roman Catholic male is eligible to be elected pope. However, since the 1300's, the pope has always been chosen from among high-ranking clergymen called *cardinals.* Together, the cardinals make up the Sacred College of Cardinals, and serve as the pope's chief advisers.

Almost all popes have been Italian. In 1978, John Paul II became the first non-Italian pope since 1523. John Paul was born in Poland.

The powers of the pope

The pope has two basic types of powers: *spiritual* and *temporal.* Spiritual powers are concerned with faith, morals, religious practices, and church government. Temporal powers involve the civil administration of Vatican City as an independent state.

Roman Catholics believe that the pope is *infallible* (incapable of error) when he speaks for all the church on matters of faith and morals. The pope is not considered infallible on other aspects of church affairs. However, he

does have absolute jurisdiction. For example, he can make laws for the entire church. He appoints cardinals, appoints or removes bishops, establishes and divides *dioceses* (church districts headed by bishops), and approves new religious *orders* (brotherhoods or sisterhoods).

For a period during the Middle Ages, the pope exercised considerable temporal, as well as spiritual, power. From 756 to 1870, the papacy controlled provinces and cities in central Italy, including Rome, called the Papal States. Today, the pope's temporal responsibilities are limited to ruling Vatican City, the smallest independent country in the world. Vatican City has an area of 109 acres (44 hectares) and a population of about 1,000. It has its own flag, coins, stamps, public works, and communications systems. The pope sends representatives, called *nuncios,* to other independent states and receives foreign diplomats.

As the leader of hundreds of millions of Roman Catholics around the world, the pope can speak as an influential international leader. Popes have spoken on a variety of religious and *secular* (nonreligious) subjects. Modern popes have issued strong, sometimes controversial, statements on such political issues as government tyranny, and on birth control and other matters involving the family.



Paul VI officiating at a Mass (Fotocronache Olympia)

The pope's vestments for saying Mass include a white skullcap, a woolen collar called a *pallium,* and a sleeveless garment called a *chasuble* worn over a long white cassock.

Titles, clothing, and symbols

The pope is addressed as "Your Holiness." He speaks of himself in official documents as "servant of the servants of God." Each man who is elected pope traditionally takes a new name for use during his reign. Most popes choose the name of an earlier pope whom they admire.

Like other clergy, the pope wears distinctive religious clothing called *vestments.* In general, his garments are the same style as those worn by a bishop. The pope's everyday clothing includes black trousers, a collarless white shirt, a clerical collar, a white skullcap, and a long white garment called a *cassock* with a sash. For public appearances, the pope may wear a short red cape called a *mozzetta;* and a circular collar of white wool, called a *pallium,* which rests on the shoulders. The pallium is embroidered with six black crosses. The pope also wears low red shoes.

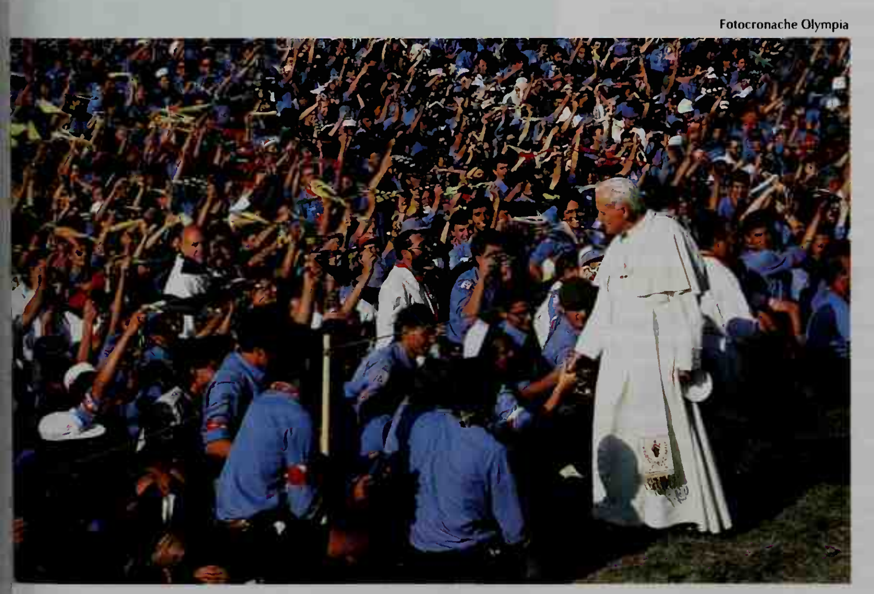
The pope wears a cross made of gold, called a *pectoral cross.* The pope's jewelry also includes a ring known as the *fisherman's ring.* It shows Peter in his occupation as a fisherman and symbolizes the pope's role as a "fisher of men."

The daily life of the pope

The pope lives in the Vatican Palace most of the year. During the summer, he moves to the papal villa in the small town of Castel Gandolfo in the Alban Hills southeast of Rome. This section describes a typical day in the life of John Paul.

The pope rises each morning by 6 a.m. The pope's

Fotocronache Olympia



The daily life of the pope includes meeting with groups of Roman Catholics who visit Rome. In this picture, John Paul II greets a gathering of Boy Scouts. The pope also holds regular receptions called *audiences* in Vatican City for visitors.

simply furnished bedroom has a bed with a red, hand-embroidered bedspread and a desk where the pope does most of his writing. The room also has a kneeler that the pope uses for private prayer.

After dressing and completing his private prayers, the pope is met at his bedroom by two priest-secretaries who escort him to a nearby papal chapel where he says Mass. John Paul often invites guests to this 7 a.m. Mass.

After breakfast from 8:30 to 9 a.m., the pope meets with two assistants, called *prefects,* who brief him on his daily schedule and diplomatic developments. John Paul then attends meetings and handles paperwork before holding private *audiences* (receptions) that begin at 11 a.m. Visitors to Rome and people who have business with the Holy See attend these audiences, which last 15 to 20 minutes. The pope also holds a general audience every Wednesday that may attract up to 12,000 people indoors and 40,000 outdoors in St. Peter's Square in Vatican City.

Lunch with guests is served about 1:30 or 2 p.m. After lunch, the pope rests for 30 minutes and then goes to the roof garden above his apartment in the Vatican Palace for some fresh air and a bit of walking. Earlier in his reign, John Paul enjoyed brisk walking, jogging, swimming, and skiing. However, the effects of an assassination attempt, surgery for a colon tumor, a hip injury, and aging have reduced his physical activity.

The pope works alone until 6:30 p.m. Then he meets various Vatican officials, such as his secretary of state, until dinner is served at 8 p.m. If there are dinner guests, they will be Vatican officials. If there are no guests, the pope watches television news during dinner and then perhaps a soccer game or a motion picture. After more time in his study, John Paul makes a final visit to the chapel at 11 p.m. for night prayers called *compline.* He then goes to bed.

The first Saturday of each month, the pope leads a recitation of the rosary over the Vatican radio. He schedules visits to local parishes in Rome on many Sundays.

The election of a pope

Early days. During the history of the papacy, procedures for electing a new pope have varied. Until the 300's, popes were elected by a kind of local election involving clergy from Rome and nearby areas. For many centuries, kings, emperors, and other secular leaders interfered in the election process and tried to influence the outcome. At various times, an *antipope* set himself up in opposition to the pope who had been elected legally. An antipope is a man determined to have improperly claimed to be or served as pope. Sometimes emperors or factions within the church itself supported antipopes.

Major features of the present electoral procedure date back to 1059, when Pope Nicholas II (1059-1061) declared that papal electors must be cardinals. In 1179, Pope Alexander III (1159-1181) presided over the Third Lateran Council, which established that all cardinals had an equal vote and election required a two-thirds majority. In 1274, Pope Gregory X (1271-1276) took steps to prevent election delays by requiring all cardinals to meet within 10 days of a pope's death. They had to remain together in strict seclusion from the outside world until they elected a new pope. By the late 1500's, most electoral procedures now in effect had been adopted.

Present procedures. When a pope dies, the dean of the Sacred College notifies all cardinals of the vacancy. They are called to a *conclave* (meeting) at Vatican City that must begin no more than 20 days after the death.

The election process is carefully controlled. Blank ballots are prepared and distributed. By lot, the cardinals choose from their group three who collect the ballots of the infirm, three *tellers* (counters of the votes), and three reviewers of the results. After these officials are chosen, each cardinal writes the name of one preference on a ballot. Then each cardinal, in order of seniority, approaches an altar to pledge his integrity of purpose. He then places the folded ballot in a receptacle covered by a plate. Only cardinals under the age of 80 may vote. After all the votes are submitted, the three tellers read each ballot. The last teller reads the results aloud to the cardinals. Two votes are taken every morning and two every afternoon until one man receives two-thirds of the votes, plus one. If no pope has been elected by a two-thirds majority after a certain number of ballots, the cardinals may agree to elect by a simple majority.

After the required majority has been reached, the dean asks the man selected if he accepts his election. If he does, he immediately has full and absolute jurisdiction over the entire church. The dean asks the pope what name he chooses and announces the name to all the cardinals. The cardinals then pay their respects to the new pope.

A large crowd usually gathers in St. Peter's Square to await the outcome of the election. They follow the balloting by watching the smoke that comes from a chimney on the palace roof. All ballots are burned after counting. If the necessary majority is not reached, the ballots are burned in a way that creates black smoke. After the final vote, the ballots are burned in a manner that creates white smoke to signal the election. The oldest cardinal announces the choice to the waiting crowd,



François Lochon, Gamma/Liaison

The election of a pope is announced to the outside world by white smoke emerging from a chimney in Vatican City. The smoke comes from the burning of the ballots after the final vote.



Detail of a tempera painting on wood (early 1300's) by Giotto; Pinacoteca Vaticana, Rome (SCALA/Art Resource)

Saint Peter is considered the first pope. Roman Catholics believe that Jesus Christ established the office through Peter.



Fresco (mid-1600's) by Il Borgognone; Santa Maria della Passione, Milan, Italy (SCALA/Art Resource)

Saint Gregory I established the temporal power of the papacy through his skill as a statesman and administrator.



Fresco (1200's) by an unknown artist in the Holy Cave in Subiaco, Italy (SCALA/Art Resource)

Innocent III was the most powerful of all medieval popes. He influenced the political affairs of much of Europe.

and the pope delivers his first blessing to Rome and to the world. An official coronation is held at a later date.

History

The early papacy. During the early years of Christianity, each local church was independent and led by its own elected bishop. Bishops communicated with one another through letters and personal visits, but they did not have to consult one another on religious questions. Consulting the bishop of Rome was not required, but many churches did so because of Rome's special place in Christian history. As early as the 90's, Pope Saint Clement I (about 92-101) was asserting the Roman See's *primacy* (superior authority) over other churches.

Christians gained freedom of worship in the Roman Empire during the reign of Constantine the Great in the early 300's. The status of the bishop of Rome increased as a result. However, Constantine moved his imperial capital from Rome to Constantinople (now Istanbul, Turkey), and the city was dedicated in 330. After this move, some church leaders in the East came to believe that the See of Constantinople should have equal authority with Rome. Pope Saint Leo I (440-461) argued forcefully for the primacy of the Roman See. He believed that through divine and Biblical authority, the bishop of Rome inherited a "fullness of power" from Peter and was the apostle's legitimate and legal successor.

The early Middle Ages. By the 400's, the Roman Empire in the West was threatened with destruction from repeated invasions by barbarian tribes. These invasions reduced papal authority, which was also weakened by the growth of *heresy* (false doctrine) among Christians in large parts of Africa and Spain.

Pope Saint Gregory I (590-604) defended Italy from barbarian attack. He organized papal lands throughout Italy and Sicily, and collected enough taxes to feed the Roman population and pay Roman soldiers. In the 590's, Gregory made peace with the invading Lombard tribe, which was threatening Rome. Gregory's leadership established the temporal power of the papacy. The conversion of England to Christianity was begun during his reign, and he strengthened the church in Spain, France, and northern Italy.

Hundreds of years of conflict between the Eastern and Western churches led to a historic dispute between Pope Saint Nicholas I (858-867) and Photius, the patriarch of Constantinople. A complete *schism* (split) between the Eastern and Western churches took place in 1054, during the papacy of Pope Saint Leo IX (1049-1054).

Other internal threats to the survival of the papacy emerged during the 800's and 900's. The papacy's reputation and influence declined as Roman nobles tried to control the office through *simony* (selling of church offices), intrigue, and even assassination. Eventually, beginning in the 900's, monks from the Benedictine monastery at Cluny, France, led a reform movement to eliminate simony and the practice of clergy being married. By religious law, clergy were supposed to be *celibate* (unmarried).

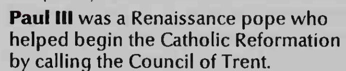
Pope Nicholas II (1059-1061) supported the Cluniac reforms. He restricted the rights of married priests and issued a decree that papal electors must be cardinals, which was directed mainly at simony.

The peak of papal power. Reforms continued under Pope Saint Gregory VII (1073-1085), who issued strongly worded decrees against simony and *lay investiture.* Through lay investiture, secular rulers granted church offices to the clergy of their choice. Lay investiture had given secular leaders considerable influence in church affairs and often allowed unqualified people to receive important religious positions. In a document issued in 1075, Gregory claimed that the pope had the power to depose both temporal and spiritual leaders. He stated that the pontiff held legislative and judicial power over all Christians.

Pope Innocent III (1198-1216) was the most powerful of all medieval popes. He influenced the political affairs of much of Europe and encouraged the establishment of the Franciscan and Dominican religious orders. Innocent was a great administrator and *jurist* (legal expert).



Oil painting on wood (1543) by Titian; Museo Capodimonte, Naples, Italy (SCALA/Art Resource)

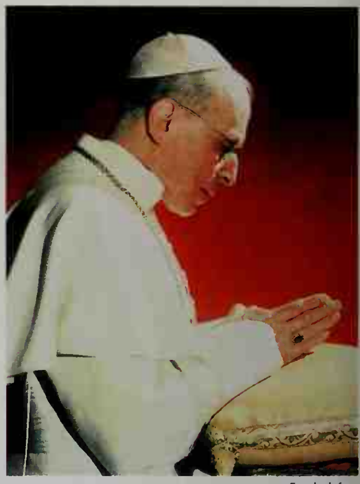


Paul III was a Renaissance pope who helped begin the Catholic Reformation by calling the Council of Trent.



Oil painting on canvas (1740's) by Giuseppe Maria Crespi; Pinacoteca Vaticana, Rome (Giraudon/Art Resource)

Benedict XIV was admired for his high moral character and his support of religious and secular education.



Farabolafoto

Pius XII was one of the most active popes in history, updating and revising many church practices and customs.

He helped make it common practice to refer to the pope by the more exalted title "Vicar of Christ," instead of such older titles as "Vicar of St. Peter."

The papal claim to primacy was expressed dramatically by Pope Boniface VIII (1294-1303) in a *bull* (papal decree) of 1302 called *Unam sanctam.* In the bull, Boniface claimed that every human being's salvation depended upon submission to the authority of the pope. Boniface saw the pope as Christ on earth, the exclusive instrument of salvation.

The troubles of the papacy. During much of his reign, Boniface VIII came into conflict with the French king, Philip IV. In 1303, soldiers led by a French official took the pope prisoner at his family home at Anagni, Italy. Although the pope was released after three days, the episode symbolized the end of the medieval attempts to broaden papal power over Europe's secular rulers. From 1309 to 1377, the popes resided at Avignon, in what is now France. This period, sometimes called the *Babylonian Captivity,* introduced a time of turmoil in the papacy known as the *Great Schism.*

The Great Schism lasted from 1378 to 1417. During this time, candidates from Avignon and Rome both claimed to be the rightful pope. In 1409, the Council of Pisa tried to untangle the dispute but instead created a third claim to the office. Finally, the Council of Constance resolved the conflict in 1417. One man *abdicated* (resigned) and the two other candidates were deposed. A new pope, Martin V (1417-1431), was elected in their place as the single legitimate pontiff.

Renaissance and Reformation. The Renaissance was a European cultural movement that began in Italy during the early 1300's and spread throughout western Europe over the next 200 years. It stimulated perhaps the most powerful social force of modern times, the spirit of nationalism. This spirit showed itself in national antipapal attitudes in France and England. Taking advantage of such attitudes, the French and English kings forced the papacy to grant to royalty sizable shares of church taxes and property. The slow loss of church funds resulted in a loss of papal power, which was transferred to secular rulers. National churches in England and France developed as rivals to the international church ruled by the pope.

Many Renaissance popes were sophisticated Italian princes who came from prominent Italian families like the Borgias and the Medicis. Many were educated as diplomats, secular scholars, or patrons of the arts, but not as religious leaders.

A number of Renaissance popes were notable for their questionable moral character. Popes from the Italian nobility often combined worldly attention to the arts with promoting their powerful families. Pope Sixtus IV (1471-1484) was a patron of the arts and scholarship. He also made three of his nephews cardinals. One of them became Pope Julius II (1503-1513). Julius II appeared interested in reform. He was a shrewd administrator and supported the work of the famous artists Raphael and Michelangelo. However, Julius was more concerned with political and military affairs than with the religious life of the church. He achieved no significant reform and did nothing to improve the papacy's moral image.

Toward the end of the Renaissance, several popes did attempt internal reforms. By this time the church was facing the threat of the Protestant Reformation, a movement that had swept through large parts of Europe. The Protestants did not accept the authority of the pope, and they broke away from the Catholic Church. A Catholic renewal movement known as the Counter Reformation, or Catholic Reformation, developed in the 1500's and 1600's. Pope Paul III (1534-1549) called the Council of Trent, which met periodically from 1545 to 1563. At the council, bishops struggled to reform church practices as well as to define Catholic belief. Paul III also formally approved the Society of Jesus (known as the Jesuits), a religious order established in 1534. The Jesuits became an influential group whose members pledged their loyalty directly to the pope.

Church efforts at reform extended through the Thirty Years' War (1618-1648) in Europe. According to the



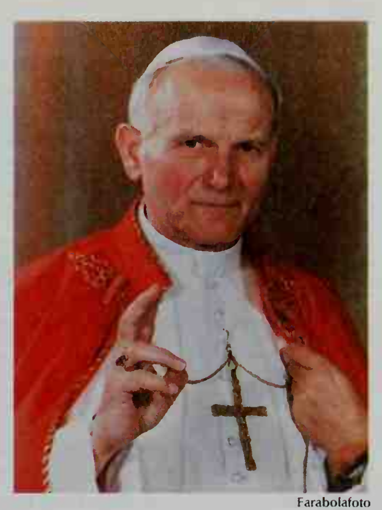
Fotocronache Olympia

John XXIII, a popular modern pope, called Vatican Council II, which reshaped much of church life.



Fotocronache Olympia

Paul VI created much controversy with a 1968 encyclical that continued church teachings prohibiting birth control.



Farabolafoto

John Paul II, who was born in Poland, in 1978 became the first non-Italian pope since Adrian VI of the Netherlands.

Peace of Westphalia that ended the war, a ruler's religion would determine the religion of the ruled area. This principle, which reflected the nationalism that was dominating Europe, further reduced the influence of the papacy, especially in Protestant Germany. By the mid-1600's, rulers of the new nation-states were viewing their power in absolute terms and challenging any papal claims to that power.

The 1700's and 1800's. During the 1700's, the papacy came under attack from several sides. A movement within the German church called *Febronianism* tried to limit claims to papal power. A similar doctrine, called *Josephism,* was put into practice by the Holy Roman emperor. In France, the *Gallicanism* movement had similar goals. At the same time, Voltaire and other French thinkers called the *philosophes* were strongly opposed to Christian churches. Their thinking influenced popular opinion against organized religion and the Roman Catholic Church in particular.

Pope Benedict XIV (1740-1758) was probably the most admired pontiff of the 1700's. He gained respect from both Protestants and Catholics for his enlightened reign. Benedict was a skillful administrator and tried to strengthen the moral influence of the papacy. He encouraged education and founded academies for the study of Christian and Roman history.

During much of the 1800's, the popes joined with conservative political forces who were ruling Europe. These forces supported the church because of its long tradition as a stabilizing social influence. Its conservative alliances put the papacy into further opposition with European liberals, who were often antipapal. The liberals claimed that the church was blocking scientific and political progress.

Pope Pius IX (1846-1878) ruled longer than any pope in history. Pius originally had been a liberal who favored unification of territories like the Italian states. But continued threats to papal power from Italian nationalists turned him into a strong conservative. In his *Syllabus of Errors* (1864), he condemned what he believed were errors of modern thought, including liberalism, rationalism, communism, and socialism. By 1870, all of the land that had once made up the Papal States was part of the independent kingdom of Italy. The pope's territory was reduced to the Vatican and Lateran palaces and the papal villa at Castel Gandolfo. Pius shut himself inside the Vatican and considered himself a prisoner. His successors followed the same policy for nearly 60 years, until the Lateran Treaty created the independent country of Vatican City in 1929.

As the political power of the popes decreased, their display of authority within the church grew stronger. The papacy presented itself as guardian of a clearly defined system of beliefs, opposed to Protestantism and the main currents of modern thought.

The papacy today. The popes of the 1900's became extremely active teaching church doctrines and morals. Their encyclicals (pastoral letters) influenced Catholic thinking on a wide range of issues. These issues included social justice, family life, the value of the sciences, and the legitimacy of other faiths. At the same time Catholic thought came into greater harmony with major intellectual developments, especially in such fields as philosophy, the natural sciences, history, and Biblical studies.

John XXIII (1958-1963) became one of the most popular of all modern popes. He called Vatican Council II to provide a renewal and updating of Catholic religious life and doctrine. The council opened in 1962 and ended in 1965, after John's death. One of the council's most challenging themes was *collegiality,* the idea that authority in the church is shared by the pope and a consensus of bishops and other clergy. John's successor, Paul VI (1963-1978), presided over the final years of the council. He withdrew controversial questions of celibacy and birth control from the council and reserved action on these topics to himself.

In 1978, John Paul II was elected the first non-Italian pope since Adrian VI (1522-1523) of the Netherlands. John Paul established himself as one of the most active

The popes

Name	Start of reign
*St. Peter (the Apostle)	Unknown
St. Linus	A.D. c. 67
St. Anacletus (Cletus)	c. 76
*St. Clement I	c. 92
St. Evaristus	c. 101
St. Alexander I	c. 105
St. Sixtus I	c. 115
St. Telesphorus	c. 125
St. Hyginus	c. 136
St. Pius I	c. 140
St. Anicetus	c. 155
St. Soter	c. 166
St. Eleutherius	c. 175
St. Victor I	189
St. Zephyrinus	199
St. Calistus I	217
St. Hippolytus	217
St. Urban I	222
St. Pontianus	230
St. Anterus	235
St. Fabian	236
St. Cornelius	251
Novatian	251
St. Lucius I	253
St. Stephen I	254
St. Sixtus II	257
St. Dionysius	259
St. Felix I	269
St. Eutychian	275
St. Caius	283
St. Marcellinus	296
(See vacant about 4 years.)	
St. Marcellus I	308
St. Eusebius	309
St. Melchiades or Miltiades	311
*St. Sylvester I	314
St. Marcus	336
St. Julius I	337
Liberius	352
Felix II	355
St. Damasus I	366
Ursinus	366
St. Siricius	384
St. Anastasius I	399
St. Innocent I	401
St. Zosimus	417
St. Boniface I	418
Eulalius	418
St. Celestine I	422
St. Sixtus III	432
*St. Leo I, the Great	440
St. Hilary	461
St. Simplicius	468
†St. Felix III (II)	483
*St. Gelasius I	492
Anastasius II	496
St. Symmachus	498
Lawrence	498; 501
St. Hormisdas	514
St. John I	523
†St. Felix IV (III)	526
Boniface II	530
Dioscorus	530
John II	533
St. Agapitus I	535
St. Sylverius	536
Vigilius	537
Pelagius I	556
John III	561
Benedict I	575
Pelagius II	579
*St. Gregory I, the Great	590
Sabinian	604
Boniface III	607
St. Boniface IV	608
St. Deusdedit or Adeodatus I	615
Boniface V	619
*Honorius I	625
(See vacant 1 year and 7 months.)	
Severinus	640
John IV	640
Theodore I	642
St. Martin I	649
St. Eugene I	654
St. Vitalian	657
Adeodatus II	672
Donus	676
St. Agatho	678
St. Leo II	682
St. Benedict II	684
John V	685
Conon	686
Theodore	687
Paschal	687
St. Sergius I	687
John VI	701
John VII	705
Sisinnius	708
Constantine I	708
St. Gregory II	715
St. Gregory III	731
St. Zachary	741
‡Stephen II (III)	752
St. Paul I	757
Constantine	767
Philip	768
‡Stephen III (IV)	768
Adrian I	772
*St. Leo III	795
‡Stephen IV (V)	816
St. Paschal I	817
Eugene II	824
Valentine	827
Gregory IV	827
John	844
Sergius II	844
St. Leo IV	847
Benedict III	855
Anastasius	855
St. Nicholas I	858
Adrian II	867
John VIII	872
Marinus I	882
St. Adrian III	884
‡Stephen V (VI)	885
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‡Stephen VII (VIII)	928
John XI	931
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*Sylvester II	999
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Benedict IX	1032
Sylvester III	1045
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Gregory VI	1045
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Benedict IX (3rd time)	1047
Damasus II	1048
*St. Leo IX	1049
Victor II	1055
‡Stephen IX (X)	1057
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*Nicholas II	1059
Alexander II	1061
Honorius II	1061
*St. Gregory VII	1073
Clement III	1080
(See vacant 1 year.)	
Victor III	1086
*Urban II	1088
*Paschal II	1099
Theodoric	1100
Albert	1102
Sylvester IV	1105
Gelasius II	1118
Gregory VIII	1118
Calistus II	1119
Honorius II	1124
Celestine II	1124
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Anacletus II	1130
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*Eugene III	1145
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*Alexander III	1159
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*Honorius III	1216
*Gregory IX	1227
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(See vacant 1 year and 8 months.)	
*Innocent IV	1243
Alexander IV	1254
Urban IV	1261
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(See vacant 2 years and 9 months.)	
*Gregory X	1271
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Honorius IV	1285
Nicholas IV	1288
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St. Celestine V	1294
*Boniface VIII	1294
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*Martin V	1417
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*Nicholas V	1447
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Antipopes in _italics._
Sources: _Catholic Almanac_ and _New Catholic Encyclopedia._
*Has a biography in _World Book._

†An error in numbering occurred when another St. Felix was mistakenly included as a pope in some earlier lists. Popes St. Felix III and IV and antipope Felix V should each be moved up.
‡In 1961, the church dropped Stephen II, who died in 752, from the list of popes. The numbers of the others named Stephen were moved up.

popes in church history. He has traveled more and been seen by more people around the world than any previous pontiff.

Willingness to deal with important social and political issues has helped increase the prestige of the papacy. But confronting these issues has also created tensions between liberals and conservatives within the church. Some of these tensions center on sensitive social topics, such as abortion, women's rights, and divorce. Others concern relations between the Holy See and members of the Roman Catholic Church as well as relations with other Christian churches and non-Christian religions.

Runald Burke

Related articles in *World Book.* See the separate biographies of popes listed with asterisks in the *table* with this article. See also:

Archbishop	Encyclical	Saint Peter's Basilica
Bishop	Papal States	Swiss Guard
Bull	Reformation	Vatican City
Cardinal	Roman Catholic Church	Vatican Council I
Christianity		Vatican Council II
Counter Reformation		

Outline

I. The powers of the pope
II. Titles, clothing, and symbols
III. The daily life of the pope
IV. The election of a pope
A. Early days
B. Present procedures
V. History

Questions

According to church doctrine, when is the pope *infallible*?
Where does the pope live during the summer?
Who can elect a new pope? How many votes are needed?
What Biblical passage do Roman Catholics cite as authority for the office of pope?
What was the importance of the reign of Pope Saint Gregory I?
What was the Babylonian Captivity? The Great Schism?
How is the pope addressed?
Who was the first pope?
What sensitive social and religious issues face the papacy?
What was the significance of Gallicanism, Febronianism, and Josephism?

Additional resources

Duffy, Eamon. *Saints & Sinners: A History of the Popes.* Yale, 1997.
McBrien, Richard P. *Lives of the Popes.* Harper San Francisco, 1997.
McClory, Robert. *Power and the Papacy.* Triumph Bks., 1997.

Pope, Alexander (1688-1744), was the greatest English poet of the early 1700's. His brilliant verse satires ridiculed many kinds of human follies. Pope's biting wit made him one of the most feared writers in England.

Pope wrote in heroic couplets, with two rhymed lines of 10 syllables each. His polished, concise verse shows a keen feeling for sound and rhythm. Pope has become one of the most quotable poets. He wrote many famous lines, including a couplet from *An Essay on Criticism* that expressed his literary creed:

> True wit is Nature to advantage dress'd,
> What oft was thought, but ne'er so well express'd.

Pope's career can be divided into three periods. During the first period, from about 1709 to 1715, he wrote *An Essay on Criticism* (1711). This witty poem about criticism and writing made him famous at the age of 23. It includes two famous lines: "A little learning is a dangerous thing" and "To err is human, to forgive divine." Pope's *The Rape of the Lock* (1712, 1714) is the most famous mock-epic poem in the English language. In the poem, Pope satirizes the vanities of fashionable people. *The Rape of the Lock* tells about a pretty young woman whose lock of hair is snipped off by a suitor at a party. A "battle of the sexes" follows, and Pope states his moral:

> Oh! if to dance all night, and dress all day
> Charm'd the smallpox, or chased old age away,
> Who would not scorn what housewife's cares produce,
> Or who would learn one earthly thing of use?

During his second period, from 1715 to 1726, Pope devoted himself to translating and editing. His translation of the Greek epic poem the *Iliad* (1715-1720) made him financially independent. With the profits, Pope bought a villa at Twickenham in 1719, and he spent most of his remaining years there writing.

During his last period, Pope wrote his most serious satires. They express his belief in the value of common sense, a moral life, friendship, poetry, and good taste. *An Essay on Man* (1733-1734) is a long, ironic, philosophical poem. It includes the well-known line "Hope springs eternal in the human breast." Pope's four *Moral Essays* (1731-1735) are satirical poems in the form of letters. One of these poems lightly exposes the follies that Pope saw in women, and another ridicules people who misuse wealth.

Imitations of Horace (1733-1738) is patterned after the verse *epistles* (letters) and satires of the Roman poet Horace. The poem is prefaced by "An Epistle to Dr. Arbuthnot" (1735). In this pleasant satire, Pope created a favorable picture of the poet as a man who is independent, good, and a lover of truth. In addition, the poem attacks Pope's enemies, especially the author Joseph Addison.

Pope's last major work was *The Dunciad* (1728-1743), an attack on dunces. The poem ridicules dull writers, biased critics, overly scholarly professors, and stupid scientists. Pope particularly ridiculed the critic Lewis Theobald and the writer Colley Cibber.

Pope was born in London. At age 12, he suffered a tubercular spinal infection. As a result, he grew to an adult height of only 4 feet 6 inches (137 centimeters) and developed a hunchback. Pope was extremely sensitive about his appearance. Gary A. Stringer

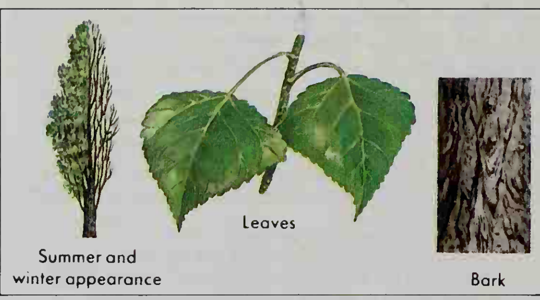
See also English literature (The Augustan Age [Swift and Pope]).

Additional resources

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Rosslyn, Felicity. *Alexander Pope.* St. Martin's, 1990.

Poplar is any one of a group of fast-growing trees that are found throughout the Northern Hemisphere. Aspens and cottonwoods are poplars. About 10 of the 35 species in the group are native to North America. These trees have pointed leaves with wavy, toothed edges. Many kinds of poplars have such flat leafstalks that even a slight breeze will cause the leaves to flutter. Early in the spring, before the leaves appear, small greenish flowers form in drooping clusters called *catkins.* Tiny seeds are hidden in fluffy, cottony hairs that make it easy for the wind to carry them through the air.

Poplars grow best in moist places. They grow easily



WORLD BOOK illustration by John D. Dawson

The balsam poplar grows in Canada and the Northern United States. Its buds and young leaves have a fragrance of balsam.

from *cuttings* (cut twigs). People often plant poplars for shade trees because they grow fast. But poplars do not live long. Also, their roots tend to clog underground drainpipes and sewers. For this reason, it is illegal in some cities to plant poplars along streets.

Poplar wood is whitish or light brown. The wood is also soft, light, and weak. Manufacturers use it to make boxes and crates. Papermakers use it for paper pulp and to make *excelsior* (wood shavings used for stuffing furniture and for packing breakable objects).

Balsam poplar, or *tacamahac,* grows across Canada. It lives as far north as trees will grow and south to the Northern United States. The sticky buds and young leaves have an odor of balsam. Honey bees use the fragrant gummy substance to waterproof their hives. *Balm of Gilead,* a cultivated variety, has heart-shaped leaves.

The *white poplar* has leaves that are silvery white beneath and have three or five lobes like a maple leaf. The bark on the branches is white. The *Lombardy poplar* is tall and narrow and has diamond-shaped leaves. Its branches point upward. The white and Lombardy poplars are native to Europe and have been introduced into the United States. People often planted these poplars in rows in formal gardens and for roadside landscaping. But their popularity as landscape trees has declined because they are easily damaged by insects, wind, and disease. These trees do not produce seeds.

The *Carolina poplar* is a hybrid derived from the native eastern cottonwood and the black poplar from Europe. This type has triangular leaves. It can endure city smoke and dust and often is seen growing in large cities. All Carolina poplar trees are male and do not produce the cottony seeds found in other varieties.

Richard C. Schlesinger

Scientific classification. Poplar trees belong to the willow family, Salicaceae. Balsam poplar is *Populus balsamifera;* white poplar is *P. alba,* Lombardy poplar is *P. nigra,* var. *italica.* Carolina poplar is *Populus canadensis.*

See also **Aspen; Cottonwood.**

Popocatépetl, *PAW paw kah TEH PEHT uhl* or *POH puh KAT uh PEHT uhl,* is a volcanic mountain that lies about 45 miles (72 kilometers) southeast of Mexico City (see **Mexico** [terrain map]). Popocatépetl is one of North America's highest mountains, rising 17,887 feet (5,452 meters) above sea level. Mount McKinley, highest mountain on the continent, is only 2,433 feet (742 meters) taller than Popocatépetl. The summit of Popocatépetl is covered with snow. Evergreen forests grow on its lower slopes.

Since at least the 1300's, Popocatépetl has erupted from time to time, spewing out gas, steam, smoke, and ash. Because of these periodic eruptions, the Aztec who lived nearby named the volcano Popocatépetl, which means *smoking mountain.* Popocatépetl is often called simply "Popo."

During the 1520's, soldiers in the army of Spanish conqueror Hernando Cortés entered Popocatépetl's crater to obtain sulfur to make gunpowder. Some mining for sulfur has taken place since then. Popocatépetl has become a popular mountain-climbing site.

John J. Winberry

See also **Mexico** (picture: The Central Plateau); **Mountain** (diagram: Major mountains).

Popper, Karl Raimund (1902-1994), was an Austrian-born philosopher whose central concern was analyzing the nature of science. In his major work, *The Logic of Scientific Discovery* (1935), Popper argued that science does not begin with the gathering of evidence through observation of the world. It begins with the formulation of scientific *hypotheses* (laws or theories to be tested). The formulation of hypotheses is a creative act that precedes, shapes, and makes possible the gathering of any evidence. According to Popper, evidence is gathered only to test some already formulated hypothesis.

In his popular work *The Open Society and Its Enemies* (1945), Popper argued that the admired philosophers Plato, G. W. F. Hegel, and Karl Marx were enemies of freedom because they laid the intellectual foundations for the totalitarian state.

Popper was born in Vienna and taught there until 1937 when he left the country because of the rise of the Nazis. He taught at the London School of Economics and Political Science from 1949 to 1969. Queen Elizabeth II knighted him in 1965, making him Sir Karl Popper.

Ivan Soll

Poppy is the common name for several related groups of flowers. The most important member is the white, pink, red, or purple opium poppy of China, India, and Iran. It has been raised in the Orient since ancient times.

The flowers of poppies are admired for their delicate beauty and gracefulness. Breeders have produced many variations in the size and form of the blossom. Most kinds are hardy and easy to cultivate. The tiny seeds have no narcotic properties, and they are sold for bird food. They also yield an oil used in preparing some foods. The oil cake remaining is a valuable cattle food. Poppy seeds are also used as flavoring. Poppy seeds may be sprinkled on bread and rolls, or used in filling for cakes.

The common corn poppy grows wild in the grainfields and grassy meadows of Europe. Many varieties of the corn poppy, including the *Shirley poppy,* are grown from seed in flower gardens. The *Iceland poppy* grows as far south as Colorado. Its long-lasting flowers are various shades of white, orange, yellow, rose-pink, and scarlet. The California poppy, or "cup of gold," grows wild in the "Golden State." The most showy poppy is the large-flowered Oriental poppy. This poppy's red, orange, white, or salmon blossoms often have blackish-purple centers.

Many poppies are annual plants that can be grown from seed. However, the Oriental poppy is a perennial, and this plant is best transplanted by root sections. The

poppy is one of the flowers of the month of August.

Opium comes from the young capsules of the opium poppy where the seeds develop. To obtain it, workers scratch the capsules late in the day. The milky juice that seeps out solidifies overnight, and is collected the next day. It takes 120,000 capsules to yield 25 to 40 pounds (11 to 18 kilograms) of opium.

Scientific classification. The poppy family is Papaveraceae. The opium poppy is *Papaver somniferum;* the corn poppy, *P. rhoeas;* the Iceland poppy, *P. nudicaule;* the Oriental poppy, *P. orientale.* The California poppy is *Eschscholtzia californica.*

Roy E. Gereau

See also **Celandine; Flower** (pictures: Garden perennials; Flowers of the arctic tundra; Flowers of summer-dry regions); **Opium**.

Popular music is music created as a commercial product. It is usually distinguished from classical music and from folk music. Classical music is written chiefly for concerts, operas, and ballets. Folk music is the traditional music of a particular group or community of people, such as an occupational, ethnic, or regional group. Folk music is usually learned by listening to another person rather than by reading music.

There are many different styles of popular music in the United States, including bluegrass, blues, country, gospel, jazz, musical comedy, rap, reggae, and rock. In some cases, the categories of popular, folk, and classical music overlap. For example, jazz and country music evolved out of folk traditions. Some styles, such as blues and bluegrass, exist both as popular music and as folk music. Such classical composers as Leonard Bernstein and Louis Moreau Gottschalk have written pieces in the style of popular music.

Although much popular music expresses sentiments of love, other popular songs serve as a vehicle for social commentary. Popular music is frequently thought to have meaning only for the time in which it was created. However, many popular songs have endured for decades.

Popular music before recording

The colonial period (1607-1776). Before the Revolutionary War in America (1775-1783), virtually the only music published in the American Colonies was religious music. Much of it consisted of settings of hymns and psalms by William Billings and other composers. People sang these pieces in church, at gatherings in their homes, and in singing societies. Billings and other composers also ran singing schools, partly to build a market for their music.

Secular (nonreligious) music also flourished in the colonies, but much of it was passed orally from person to person, without being published. Colonists sang folk and popular songs from Great Britain and songs written by Americans in the British style. Many songs were sold on *broadsides*—large sheets of paper with lyrics printed on one side. The broadsides provided no music, only words, with directions that they were to be sung to a familiar tune.

Black slaves often performed as musicians at dances and other social functions. They played instruments from Africa, including forerunners of the banjo. They also played the violin and other European instruments.

Revolutionary War to 1840. Extensive publication of nonreligious music began in the United States in the 1790's. At that time, most American music publishing companies were located in New York City, Boston, Philadelphia, and Baltimore. These companies published sheet music, mostly for solo voice with piano accompaniment. In addition, collections of songs and instruction books for such instruments as flute, fife, and violin began to appear. Most of these volumes contained dances, marches, and other popular melodies of the time. Also common were small books called *songsters.* Like broadsides, most songsters included only the words to popular melodies.

During this period, American popular music continued to be heavily influenced by music from abroad. An Englishman, Henry Bishop, composed or arranged the music to "Home, Sweet Home," perhaps the most popular song of the 1800's. The text was written by American poet John Howard Payne. The Irish poet Thomas Moore wrote new lyrics for traditional tunes in *Irish Melodies* (1808-1834), which became extremely popular in the United States. " 'Tis the Last Rose of Summer" and "Believe Me If All Those Endearing Young Charms" were among the songs in Moore's collection to become widely popular.

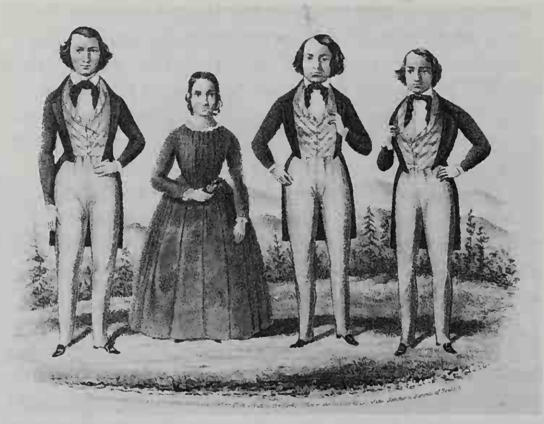
1840's to the Civil War. During the mid-1800's, American popular music began to develop its own identity. *Minstrel shows* became a popular form of entertainment. In minstrel shows, white entertainers wore blackface makeup to impersonate blacks. They performed songs, skits, dances, and comedy routines that reflected their conceptions of black life and music.

Minstrel shows were performed in a spirit of parody and did not present authentic black music. However, they did bring some basic elements of black music to large audiences for the first time. The instruments minstrels played—including banjos, fiddles, tambourines, and bones—were characteristic of slave music. Minstrel performers also incorporated the technique of banjo playing used by black musicians. "Old Dan Tucker" (1843) and "Dixie" (1859) by Daniel D. Emmett are two songs that were first performed on the minstrel stage.

The most important American songwriter of the mid-1800's was Stephen Foster, who rose to fame writing songs for minstrel shows. Foster was the first American to make his living as a songwriter. Many of his compositions, such as "Oh! Susanna", "Camptown Races" (1850), and "Old Folks at Home" (1851, also called "Swanee River"), are still popular.

Also rising to prominence in the 1840's was the Hutchinson Family—a singing group made up of three brothers and a sister from New Hampshire. The Hutchinsons were among the first American performers to use popular music as a vehicle for social commentary. For example, some of their songs protested slavery or urged an end to the use of alcohol.

The Civil War (1861-1865) was of great importance to American popular music. People often expressed in song the strong feelings aroused by the war. As a result, there was a tremendous increase in composition and publishing. Such songs as "Battle Hymn of the Republic" (1862) and "The Battle Cry of Freedom" (1862) reflected Northern attitudes. Southerners, meanwhile, expressed the sentiments of the Confederacy in "Dixie" and "The Bonnie Blue Flag" (1861).



New Hampshire Historical Society

The Hutchinson Family in the 1840's were among the first performers to use popular music for social commentary.

The Civil War also had an impact on music in many other ways. It provided musical training for soldiers who played in military bands. In addition, the war brought people from different parts of the country together. These contacts enabled people to learn about one another's musical styles, instruments, and songs. Of particular importance was the exposure Northerners gained to authentic black music, notably the religious songs called *spirituals.* Up to this time, most Northerners' conception of black music had come only from minstrel shows.

The end of slavery in the United States after the Civil War enabled a greater number of blacks to become professional musicians and songwriters. Black groups who specialized in singing spirituals became popular in the late 1800's. In addition, all-black minstrel troupes were formed during this period.

Vaudeville and musical comedy. During the late 1800's, a new type of variety show called *vaudeville* replaced the minstrel show as the dominant form of stage entertainment. Like minstrel shows, vaudeville consisted of songs, dances, comic skits, and other acts. The two differed, however, in that vaudeville reflected Northern white influences rather than black Southern culture. Vaudeville was at the height of its popularity from the 1880's to the 1930's.

By the end of the 1800's, music publishing centered in an area around 28th Street in New York City that came to be known as Tin Pan Alley. The area got its name from the noise of the cheap pianos in song publishers' offices. Musicians sometimes called these pianos "tin pans." New York City also became the hub of *musical comedy.* A musical comedy, or *musical,* is a type of play that tells a story through a combination of spoken dialogue, songs, and dances. Many of the songs published by Tin Pan Alley originated in musicals. Tin Pan Alley controlled the publication of popular music throughout the early 1900's, and musicals remained an important means for introducing new songs to the public. Musical comedy composers who wrote many popular songs during this period include Irving Berlin, George Gershwin, Jerome Kern, Cole Porter, and Fats Waller.

Ragtime, jazz, and blues. With the changes brought about by the Civil War, the South became fertile ground for new musical styles during the late 1800's. Instruments rarely used by slaves, such as pianos, guitars, and brass instruments, became central to the new styles of black music that developed and flourished during this period. Noisy bars became the usual setting for dancing. The loud piano replaced the fiddle and banjo as the favorite means of providing dance music. *Ragtime,* a style of music often played on the piano, developed in the 1890's in the Midwest. Ragtime was *syncopated* music. That is, it accented the weak beats rather than the strong beats. Music historians trace the roots of ragtime to plantation dance music such as the *cakewalk,* to minstrel shows, and to music for black stage shows. Early in ragtime's development, Scott Joplin and other composers began writing formal compositions in the ragtime style. Ragtime soon became popular throughout the United States and flourished in the first two decades of the 1900's.

Another new style of music called *jazz* developed in New Orleans around 1900. Jazz also was partially rooted



Roy Acuff and the Smoky Mountain Boys; Culver

Country music spread nationally from the South through performances by such stars as Roy Acuff, *playing the fiddle.*



Ellington and his orchestra about 1931; UPI/Bettmann

Duke Ellington, *center,* was an orchestra leader and composer who helped make jazz a major form of popular music.

in black dance music, as well as in the brass band music played in New Orleans during funeral processions and parades.

Still another new style called the *blues* became popular in the early 1900's. The blues probably developed from work songs and the calls known as *field hollers* that plantation workers used as a form of communication in the fields.

The recording era

Sound recording, invented in 1877, became an important way to distribute popular music in the early 1900's. In the 1920's, records surpassed sheet music as the primary means through which popular music was sold. With this shift, songwriters and publishers were no longer the dominant force in popular music. Instead, music began to be dominated by performers and record companies. The rise of sound recording also changed the ways in which people enjoyed popular music. Instead of gathering around the piano at home to sing the latest songs themselves, people played recordings of other people singing.

Record companies discovered and exploited new markets during the early 1900's. In the process, they helped popularize several types of music. The first recordings of jazz were made in 1917 by a group of white musicians called the Original Dixieland Jass Band. The first blues recordings were made in 1920. On some early blues records, professional blues singers such as Bessie Smith and Ma Rainey performed with some important jazz musicians. Other blues musicians, such as guitarists Charley Patton and Robert Johnson, played a more emotional style of music often called *Delta blues* because it originated in the Mississippi Delta region.

The rise of country music. The recording industry also helped spread a kind of music called *country music.* Country music combined elements of popular song, British folk music, American blues, and religious music. It was first recorded in 1922. The recordings were marketed as *hillbilly music,* partly because of a popular band called the Hill Billies.

Radio exposed people to different kinds of popular music in the 1920's and 1930's. Live radio shows such as "The Grand Ole Opry," broadcast from Nashville, Tenn., brought country music to large, new audiences.

Other new styles of popular music continued to emerge from the 1920's to the 1940's. A new type of jazz called *swing* developed in the 1930's. Big bands dominated the swing era and helped advance the careers of such musicians as Count Basie, Duke Ellington, and Benny Goodman. Musicians combined country with jazz in the 1930's to produce what later became known as *Western swing.* Country string band music gave birth to a new style called *bluegrass,* pioneered by Bill Monroe and his band, the Blue Grass Boys beginning in 1939.

The blues expanded as many blues musicians left the rural South and moved to Chicago and other Northern cities. There, in the late 1940's, they developed a style of music called *rhythm and blues.* Unlike traditional blues, rhythm and blues used electrically amplified instruments rather than *acoustic* (nonelectric) guitars.

Rock 'n' roll. Popular music underwent a major revolution in the 1950's, as young musicians combined elements of rhythm and blues, country music, and popular songs to create a new style called *rock 'n' roll* (also spelled *rock and roll*). Elvis Presley was the most significant early rock 'n' roll artist. A wave of rock groups from England became extremely popular in the United States, beginning in 1963. The Beatles were the most influential of these groups, who were inspired by American rhythm and blues and early rock 'n' roll.

The folk music revival. In the late 1950's, traditional white American folk music gained new popularity. Young, urban, college-educated performers such as the Kingston Trio had hits with the Appalachian ballad "Tom Dooley" (1958) and other folk songs. Other performers in this folk music revival were inspired by Woody Guthrie. Guthrie wrote songs that used traditional folk melodies and styles. These singer-songwriters began composing their own songs. These songs frequently had the theme of social protest. Bob Dylan, whose songs include "Blowin' in the Wind" (1962) and "The Times They Are A-Changin' " (1963), was the most important writer of this movement.

Soul music became the most popular form of black music in the 1960's. Growing out of rhythm and blues, and influenced by black gospel music, soul gained popularity with white and black audiences alike. Aretha Franklin and James Brown were important soul artists.

New forms of rock. Mainstream popular music in the 1970's was dominated by a dance-oriented rock style called *disco.* The *punk rock* and *new wave* movements popular in the mid- and late 1970's began partly as a backlash against the technical, impersonal sounds of disco.

Country rock gained more widespread acceptance during the 1970's. Such artists as the Byrds, the Eagles, Emmylou Harris, Willie Nelson, Dolly Parton, and Linda Ronstadt combined elements of rock and country in their music.

The rise of rap as the dominant form of black popular music began in the 1980's. Growing out of black street culture in New York City, rap consists of words recited over a strong rhythm track. Many rap groups use the form to comment on such social problems as racism and poverty. Some rap artists have generated controversy because their lyrics deal graphically with sex and violence.

New technologies for the spread of popular music also arose in the 1980's. Short films called *music videos* became a new means for promoting songs and artists. Some artists, such as Madonna and the Eurythmics, owe much of their success to the popularity of their videos. Compact discs (CD's) and cassette tapes overtook phonograph records as the most popular media for sound recording in the late 1980's. Paul F. Wells

Related articles in *World Book.* See Country music, Folk music, Jazz, Musical comedy, and Rock music with their lists of *Related articles.* See also:

America (song)
Banjo
Battle Hymn of the Republic
Beach Boys
Belafonte, Harry
Bland, James A.
Blues
Carmichael, Hoagy
Charles, Ray
Crosby, Bing
Dixie
Franklin, Aretha
Garland, Judy
God Bless America
Horne, Lena
Jackson, Mahalia
Jolson, Al
McKuen, Rod
Music
Rap music
Reggae
Sinatra, Frank

Sousa, John Philip
Star-Spangled Banner
Streisand, Barbra
Vaughan, Sarah
Waters, Ethel
Woodstock festival
Yankee Doodle

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Popular sovereignty, also called *squatter sovereignty,* was the doctrine that the people of a territory, rather than the United States Congress, should decide whether to permit slavery in the territory before it became a state. The theory of popular sovereignty developed during the controversy over slavery that is part of the history of the early United States.

The North, as a whole, opposed extension of slavery into any of the land acquired from Mexico after the Mexican War ended in 1848. The South almost unanimously favored expansion of slavery into this new territory. Many people on both sides found the theory of popular sovereignty a useful solution to the disagreement that relieved Congress of a difficult problem.

Lewis Cass, a Democratic senator from Michigan, probably originated the theory of popular sovereignty. But Stephen A. Douglas, a Democratic senator from Illinois, was the first person to use the term *popular sovereignty* and the idea's most prominent advocate.

The Kansas-Nebraska Act of 1854 permitted the people of the Kansas and Nebraska territories to decide for or against slavery within their respective borders. The authors of the law took for granted that Nebraska would vote free, and Kansas, slave. But antislavery advocates sent many free-state settlers into Kansas, while many proslavery residents of Missouri crossed into Kansas, sometimes to settle, but often only to vote. The bloodshed that resulted showed that the principle of popular sovereignty would not work. Soon after the American Civil War ended in 1865, slavery was abolished and the theory of popular sovereignty lost its significance.

Robert F. Dalzell, Jr.

See also **Douglas, Stephen Arnold; Kansas-Nebraska Act.**

Population of a country or other area is the total number of people who live in it. Populations change as a result of migration and a process called *natural increase.* Natural increase is the difference between births and deaths. Most countries have more births than deaths, and so their population increases, unless a net loss results from migration.

World population

The world's population rose to about 6,228,635,000 by 2002. The number of people is increasing at an annual rate of about 1.2 percent. Scholars estimate that the world's population totaled about 550 million in 1650. By 1850, the population had doubled to about 1,100 million. Since 1850, the world's population has increased nearly sixfold. See **World** (Population; diagram).

European populations in Europe and overseas increased rapidly in the 1700's as death rates dropped. But declines in birth rates reduced population growth and eventually led to a decrease in some countries. During the 1980's, European countries with decreasing populations included Hungary, Ireland, Portugal, and West Germany.

In most of Asia, Africa, and Latin America, death rates declined rapidly during the mid-1900's. Longer life spans were brought about by the reduction of famines and epidemics, by improved water supplies and sewage disposal, and by better medical care.

The populations of continents show the effects of differing rates of both migration and natural increase. The past 300 years have been a period of several great migrations, including that of Europeans to the Americas and some Pacific areas.

Asia is the most populous continent, with about three-

World population and yearly growth

Major area	Population	Yearly growth
World	6,228,635,000	1.2%
Africa	831,437,000	2.4
Asia	3,799,971,000	1.2
Australia	19,231,000	0.9
Europe	701,188,000	−0.1
North America	495,369,000	0.7
Pacific Islands (including New Zealand)	15,311,000	1.2
South America	355,418,000	1.4

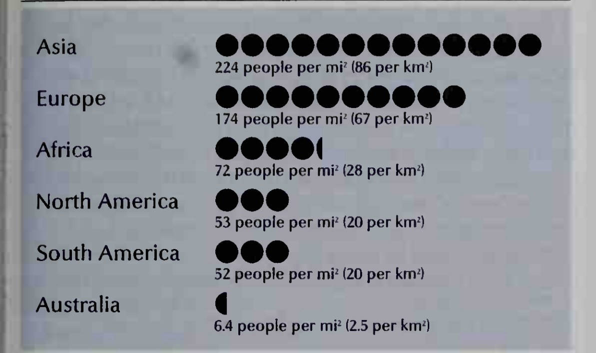
Figures are estimates for 2002.
Sources: *World Book* estimates based primarily on United Nations data; Population Reference Bureau.

Ten largest U.S. states by population

State	Population
California	33,871,648
Texas	20,851,820
New York	18,976,457
Florida	15,982,378
Illinois	12,419,293
Pennsylvania	12,281,054
Ohio	11,353,140
Michigan	9,938,444
New Jersey	8,414,350
Georgia	8,186,453

Source: 2000 census, U.S. Census Bureau.

Population density of the continents*



*Antarctica has no permanent population.
Figures are estimates for 2002.
Source: *World Book* estimates based primarily on United Nations data.

fifths of the world's population. The two countries with the largest populations are in Asia. They are China, which had nearly 1 $\frac{1}{3}$ billion people in 2000, and India, which had more than 1 billion. The two next largest countries are the United States, with about 285 million people, and Indonesia, with about 215 million.

Urban and rural population. Migration from rural areas to cities grew with industrialization in Western countries and Japan. Today, it is occurring in most countries, even in those that remain predominantly agricultural. In 1800, only about 5 percent of the people of the United States lived in places with a population of 2,500 or more. Today, about 75 percent live in places of that size or larger. In 1800, about 20 percent of the population of England lived in cities. Today, about 95 percent live in cities.

Census. Most governments conduct *censuses* (regular counts of the population) to learn the numbers, the places of residence, and the characteristics of their peoples. Most countries in the world have taken at least one census in the last 10 years. The United States government has taken a census of the American population every 10 years since 1790.

Governments also collect information on birth and death rates, called *vital statistics*. The study of the size, distribution, and characteristics of populations, and of changes in population, is called *demography*. The United Nations helps countries improve their demographic information.

Age. A population growing rapidly because of a high birth rate usually has a high proportion of children. A slowly growing population usually has a low proportion of children. Current estimates for the population of the world indicate that about 32 percent of the people are below 15 years of age. About 62 percent of the people are between the ages of 15 and 64, and fewer than 6 percent are over 64 years of age. In the United States, 21 percent of the people are less than 15 years old, 66 percent between 15 and 64, and 13 percent over 64. In Kenya and other countries with high birth rates, about half the people are below 15 years of age.

Statistics on the proportions of various age groups help society prepare for more schoolchildren, workers, or aged people. The *dependency ratio* is a comparison of the number of children and elderly people with the number of people in the main working ages. This ratio is high if a large proportion of the population are dependents. Nations with a rapidly growing population have a high dependency ratio. The support of dependents places a burden on the workers of such countries, and many children and older adults may try to find work.

United States population

In the United States, the first federal census in 1790 determined that about 4 million people lived in the country. By 2000, the United States population had increased to about 280 million. The rate of growth was highest from 1790 to 1860, when it was about 3.5 percent a year. By the 1930's, the rate had decreased to 0.7 percent a year.

Another period of rapid growth, called the *baby boom,* occurred in the United States from 1946 to 1964. The growth rate reached a high of 1.8 percent during this period. Since 1964, the rate has again slowed. Today, the growth rate is about 1 percent a year. About one-third of this growth is due to immigration rather than natural increase.

The growth of the various regions of the United States is influenced greatly by migrations within the country. Since 1970, the West has grown most rapidly and the Northeast region least rapidly. Mild climates and economic expansion attracted many people to the South and West.

Men outnumbered women throughout most of the history of the United States because men were more numerous than women among immigrants. But death rates at most ages are higher for men than for women. Thus, as immigration declined, the proportion of women increased. Since 1950, there have been more women than men in the United States. Women will likely remain in the majority despite recent high levels of immigration because today's immigrants include many family groups and single women.

The U.S. population is made up of people of many nationalities and ethnic groups. For statistical purposes, the main groups are: (1) whites who are not Hispanics (about 69 percent of the people); (2) Hispanics of any race (about 13 percent); (3) blacks who are not Hispanics (about 12 percent); (4) Asians and Pacific Islanders (about 4 percent); and (5) Aleuts, Inuit (also called Eskimos), and American Indians who are not Hispanics (less than 1 percent).

The future growth of the population depends on many factors, and it is not possible to know exactly what will happen. The U.S. Census Bureau expects that the rate of population growth in the United States will remain low. Nevertheless, the total population may reach 300 million in about the year 2006.

The population explosion

The world's population passed 5 billion in 1987, then passed 6 billion in 2000. The population is increasing by approximately 1.2 percent each year. If this rate of growth continues, the population will reach about 9 billion by the year 2035. This rapid increase has been called the *population explosion.*

Causes. For thousands of years, birth rates were high. However, the population increased slowly and some-

times declined because death rates also were high. Then, during the 1700's and 1800's, advances in agriculture, communication, and transportation improved living conditions in parts of the world and reduced the occurrence of many diseases. As a result, the death rate began to drop, and the population grew rapidly.

In the industrial countries of Europe and North America, many people flocked to the cities and took jobs in factories. In cities and in many rural areas, it was difficult to support a large family. People began to see reasons for having smaller families. As a result, birth rates in these countries began to fall. In the agricultural countries of Africa, Asia, and Latin America, declines in death rates did not occur until the mid-1900's. Then death rates plunged quickly without corresponding declines in birth rates. As a result, the population of low-income nations and of the world increased rapidly.

Effects. Many scientists, economists, and other experts fear that food production cannot keep pace with the population for long. They believe the world already is or will soon become *overpopulated*—that is, it will have more people than it can support at an acceptable standard of living. This theory was put forth by the British economist Thomas Robert Malthus in the late 1700's. Malthus stated that population tends to increase beyond the limit of the earth's ability to support it. He predicted that famine, war, and other disasters would become common unless people cut the growth rate.

Many people dispute Malthus's views. They point out that since Malthus made his gloomy forecast, world population has grown by more than 4 billion. More people are living longer and healthier lives than ever before. Many experts believe it is technologically possible to increase world food production by more than 1.7 percent yearly and thus to keep ahead of population growth. During the 1960's, for example, improved farming methods and new high-yield crop varieties helped many poor countries increase their food production by about 25 percent. This effort proved so successful that it has been called the *Green Revolution.* Some people believe that the problem is not too many people, as Malthus claimed there were, but too much inequality. They think that starvation and poverty could be overcome with a more equal distribution of existing resources. Many people have more than enough to eat, but many others go hungry.

Population control. Many experts worry that people in rich and poor countries alike consume too much, destroy forests and soil, pollute the environment, and damage prospects for human survival on earth. They believe disastrous shortages of food and other necessities can be avoided only by halting population growth. They urge that the birth rate be reduced to replacement level, an average of about 2.1 children per woman, so that only enough people are born to replace those who die. The resulting condition is called *zero population growth* or ZPG. In the United States and much of Europe, fertility is below replacement level. But in many of the world's poorer countries, women have an average of as many as 7 or 8 children.

The governments of many countries have promoted birth control programs in efforts to reduce the birth rate. China, for example, has persuaded millions of couples to have only one child. In many other countries, birth rates have declined more slowly and are still far above replacement level.

The decisions that women and men make about having children are influenced by many other factors besides government policies. These factors include their social and economic circumstances, their education, their need to have someone care for them in their old age, their feelings about the future, and their access to information and medical care. As a result, future social and economic changes will have important effects on birth rates and population growth. Karl Taeuber

Related articles in *World Book* include:

Animal (How human beings endanger animals)
Baby boom generation
Birth and death rates
Birth control
Census
City (Population growth; Metropolitan cities)
Demography
Ehrlich, Paul R.
Environmental pollution (Effects of population growth)
Food supply (Increased demand for food)
Immigration
Infant mortality
Malthus, Thomas Robert
Planned Parenthood Federation of America
Races, Human
Vital statistics
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Populism was an American political movement that attained its greatest strength during the 1890's. The Populists supported an increase in the money supply, greater government regulation of business, and other changes they believed would help farmers and laborers. In addition, they called for many reforms to increase the political power of voters. Many Populist leaders were colorful figures who stirred up the people with rousing speeches. The word *populist* also describes political policies like those of the Populists, especially policies that favor the common people.

Origins. Populism began among the farmers of the Midwest, South, and West. During the 1870's and 1880's, these farmers suffered from a combination of falling crop prices and rising operating costs. Railroad freight rates and interest rates charged by lenders caused much resentment among farmers. To address these problems, groups of farmers joined to form *farmers' alliances.*

The farmers' alliances called for the government to put more money into circulation, either by printing more paper money or by coining unlimited amounts of silver. Such a coinage policy was called *free silver.* The farmers believed an increase in the money supply would help them get higher prices for their crops. The farmers also wanted the government to regulate the railroads or take them over completely. These demands became the chief goals of the Populist movement.

The People's Party. In 1891, the farmers' alliances met with delegates from labor and reform groups in Cincinnati, Ohio, and discussed forming a new political party. They formed the People's Party, usually called the Populist Party, a year later in St. Louis, Missouri.

In 1892, the party nominated James B. Weaver of Iowa

or president and James G. Field of Virginia for vice president. Their platform called for free silver, government ownership of railroads and telegraph and telephone lines, and many political reforms. The candidates did not win, but they received more than a million popular votes and 22 electoral votes. Nine Populists were elected to Congress.

In 1896, the Democratic Party nominated William Jennings Bryan of Nebraska for president. His platform included free silver and other Populist demands. The Populists joined the Democrats in supporting Bryan, but he lost to William McKinley, the candidate of the Republican Party. The People's Party started to decline, and it disappeared by 1904.

Influences of populism. Although the People's Party faded away, many of its goals were adopted by the progressive movement and later became law (see **Progressive movement**). These goals included direct election of U.S. senators and the *initiative and referendum,* a process by which voters propose a law and vote on it. Other reforms supported by the Populists included the graduated income tax, which taxes higher incomes more heavily than lower ones, and the 8-hour workday.

Today, the word *populist* is often used to describe a politician who opposes party leaders and appeals directly to the public for support. Most of the so-called "new populists" come from rural areas, and traditional politicians regard them as outsiders. Many leaders with widely varying philosophies have been called populists. Since the 1960's, they have included President Jimmy Carter, Senator George S. McGovern of South Dakota, Governor George C. Wallace of Alabama, and Vice President Hubert H. Humphrey. Karel D. Bicha

See also **Bryan, William Jennings; Donnelly, Ignatius; Free silver; Lease, Mary E.; Watson, Thomas E.**

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Porcelain, *PAWR suh lihn,* is a type of ceramics highly valued for its beauty and strength. It is often called *china,* or *chinaware,* because it was first made in China. Porcelain is characterized by whiteness, a delicate appearance, and *translucence* (ability to let light through). Because it is the hardest ceramic product, porcelain is used for electrical insulators and laboratory equipment. However, porcelain is known primarily as a material for high-quality vases and tableware, as well as for figurines and other decorative objects. The type of porcelain that is used for such purposes produces a bell-like ring when struck.

Porcelain differs from other types of ceramics in its ingredients and in the process by which it is produced. Two common types of ceramics—earthenware and stoneware—are made from a single natural clay, which is then *fired* (baked). In many cases, the object is coated with a glassy substance called *glaze.* Firing at a low temperature produces earthenware, a porous material. Earthenware can be made waterproof by glazing. Firing at a high temperature produces stoneware, a hard, heavy material. Stoneware is nonporous without glazing.



Metropolitan Museum of Art, New York City

A Chinese vase features a deep blue *underglaze,* a design painted on the surface before the porcelain is glazed. This vase was made between 1426 and 1435, during the Ming dynasty.

Unlike earthenware and stoneware, porcelain is basically made from a mixture of two ingredients—*kaolin* and *petuntse. Kaolin* is a pure white clay that forms when the mineral feldspar breaks down. *Petuntse* is a type of feldspar found only in China. It is ground to a fine powder and mixed with kaolin. This mixture is fired at temperatures from about 2280 to 2640 °F (1250 to 1450 °C). At these extreme temperatures, the petuntse *vitrifies*—that is, it melts together and forms a nonporous, natural glass. The kaolin, which is highly resistant to heat, does not melt and therefore allows the item to hold its shape. The process is complete when the petuntse fuses itself to the kaolin.

Kinds of porcelain

There are three main kinds of porcelain: (1) hard-paste porcelain, (2) soft-paste porcelain, and (3) bone china. The differences between these types of porcelain are based on the material from which they are made. This material is called the *body* or *paste.*

Hard-paste porcelain, which is sometimes called *true porcelain* or *natural porcelain,* has always been the model and ideal of porcelain makers. It is the type of porcelain first developed by the Chinese from kaolin and petuntse. Hard-paste porcelain resists melting far better than other kinds of porcelain. For this reason, it can be fired at higher temperatures. These hot temperatures cause the body and the glaze to become one. When hard-paste porcelain is broken, it is impossible to

distinguish the body from the glaze.

The proportions of kaolin and petuntse in hard-paste porcelain may vary. The porcelain is said to be *severe* if the percentage of kaolin is high, and *mild* if the percentage of kaolin is low. Most collectors of porcelain prefer mild porcelain because of its mellow, satiny appearance. In comparison, severe porcelain may seem harsh and cold.

Soft-paste porcelain, sometimes called *artificial porcelain,* was developed in Europe in an attempt to imitate Chinese hard-paste porcelain. Experimenters used a wide variety of materials in their efforts to produce a substance that was hard, white, and translucent. They eventually developed soft-paste porcelain by using mixtures of fine clay and glasslike substances. These materials melt at the high temperatures used in making hard-paste porcelain. For this reason, soft-paste porcelain is fired at lower temperatures and does not completely vitrify—that is, it remains somewhat porous. Breaking a piece of soft-paste porcelain reveals a grainy body covered with a glassy layer of glaze.

Although soft-paste porcelain was invented in imitation of true porcelain, it has merits of its own. Most of it is creamy in tone, and some people prefer this color to pure white. In addition, the colors used to decorate it merge with the glaze to produce a soft, silky effect that appeals to many collectors.

Bone china is basically made by adding *bone ash* (burned animal bones) to kaolin and petuntse. English porcelain makers discovered this combination of ingredients about 1750, and England still produces nearly all the world's bone china. Though not as hard as true porcelain, bone china is more durable than soft-paste porcelain. The bone ash greatly increases the translucence of the porcelain.

Decorating porcelain

A piece of porcelain is shaped on a potter's wheel or in a mold. After this stage, the porcelain worker may decorate it by (1) surface modifications, (2) painting, or (3) transfer printing.

Surface modifications are achieved by *incising* (carving), *perforating* (poking holes), and *embossing* (applying raised designs). A well-known method of embossing porcelain is to apply a mixture of water and clay, called *slip,* to the item with a brush. *Relief designs* (three-dimensional effects) are usually molded separately and then attached to the porcelain.



The Metropolitan Museum of Art, New York City

A Sèvres tray made in 1767 shows the brilliant colors and gilding typical of this French porcelain. The white panel painted with birds in a landscape also became a common Sèvres design.

Painting the porcelain surface may be done in several ways. One method is to use a colored glaze, such as the famous Chinese *celadon.* This glaze is a soft gray-green color. Another type of decoration is *underglaze* (designs painted on a piece before it is glazed). A deep blue made from the metal cobalt is the most dependable color used for underglazing. Cobalt blue has been widely used both in China and in Europe. See **China** (picture: Fine white porcelain).

Paints that are applied over the glaze are commonly called *enamels.* A large variety of enamel colors were perfected at an early period. Most of them are made from metallic oxides, such as iron, copper, and manganese. Enamel colors require a second firing to make them permanent.

Porcelain painting in Europe differed greatly from porcelain painting in China. Chinese decorators separated each color from the next with a dark outline, but European artists blended colors together with no separating line. In addition, Europeans used decorations purely for their artistic value, but Chinese decorations were symbolic. For example, a pomegranate design symbolized a wish for many offspring because a pomegranate has many seeds.

Transfer printing revolutionized the porcelain industry in 1756 by enabling workers to decorate wares much faster than they could by hand. In this process, a design is engraved on a copper plate, inked with ceramic color, and transferred to tissue paper. While the color is still wet, the tissue paper is pressed against a porcelain object, leaving the design on its surface.

History of porcelain

Oriental porcelain. The Chinese probably made the first true porcelain during the Tang dynasty (618-907). The techniques for combining the proper ingredients and firing the mixture at extremely high temperatures gradually developed out of the manufacture of stoneware. During the Song dynasty (960-1279), Chinese emperors started royal factories to produce porcelain for their palaces. Since the 1300's, most Chinese porcelain has been made in the city of Jingdezhen.

For centuries, the Chinese made the world's finest porcelain. Collectors regard many porcelain bowls and vases produced during the Ming dynasty (1368-1644) and Qing dynasty (1644-1912) as artistic treasures. Porcelain makers perfected a famous blue and white underglazed procelain during the Ming period. Painting over the glaze with enamel colors also became a common decorating technique at this time. During the Qing period, the Chinese developed a great variety of patterns and colors and exported porcelain objects to Europe in increasing numbers.

By the 1100's, the secret of making porcelain had spread to Korea and to Japan in the 1500's. Workers in these countries also created beautiful porcelain objects. A Japanese porcelain called Kakiemon was first produced during the 1600's. It features simple designs on a

white background. Another well-known Japanese porcelain called Imari ware, or Arita, is famous for its dense decorations in deep blue and red.

European porcelain. As early as the 1100's, traders brought Chinese porcelain to Europe, where it became greatly admired. However, it was so rare and expensive that only wealthy people could afford it.

As trade with the Orient grew during the 1600's, porcelain became popular with the general public. The custom of drinking tea, coffee, and chocolate became widespread and created a huge demand for porcelain cups and saucers. European manufacturers responded by trying to make hard-paste porcelain themselves, but for a long time they failed to discover the secret. Nevertheless, some of their experiments resulted in beautiful soft-paste porcelain. The first European soft-paste porcelain was produced in Florence, Italy, about 1575.

By the 1700's, porcelain manufactured in many parts of Europe was starting to compete with Chinese porcelain. France, Germany, Italy, and England became the major centers for European porcelain production.

French porcelain. France became famous during the 1700's as the leading producer of soft-paste porcelain. The first factories were established at Rouen, St. Cloud, Lille, and Chantilly.

The most celebrated type of soft-paste porcelain was first produced at Vincennes in 1738. In 1756, the factory was moved to the town of Sèvres. Its soft-paste porcelain became known as Sèvres. The earliest Sèvres had graceful shapes and soft colors. Sèvres pieces produced from 1750 to 1770 were decorated with brilliant colors and heavy gilding. Many of these pieces had richly colored backgrounds and white panels painted with birds, flowers, landscapes, or people. Sèvres is also noted for its fine figurines of *biscuit* (unglazed porcelain).

Beginning in 1771, a hard-paste porcelain industry developed near Limoges, where kaolin deposits had been discovered. By the 1800's, Limoges had become one of the largest porcelain centers in Europe. An American named David Haviland opened a porcelain factory at Limoges in 1842 to make tableware for the American market. Haviland porcelain features soft colors that blend together and small floral patterns.



Metropolitan Museum of Art, New York City

A Meissen figurine of the mid-1700's was created by Johann Kändler, a German artist famous for his beautifully designed and decorated porcelain figures of people and animals.

German porcelain. A German chemist named Johann Friedrich Böttger discovered the secret of making hard-paste porcelain in 1708 or 1709. This discovery led to the establishment of a porcelain factory in Meissen in 1710. Meissen porcelain is sometimes called Dresden because Böttger first worked near the city. For nearly a century, it surpassed in quality all other hard-paste porcelain made in Europe.

The great success of Meissen porcelain can be partly attributed to the fine artists who decorated it. They painted the wares with an amazing variety of colors and designs. Johann Höroldt (or Herold), who became chief painter in 1720, produced beautiful Chinese and Japanese as well as European designs. Johann Kändler, who worked from about 1730 to 1770, is famous for his exquisite figures of animals and people.

Political disorder in Germany and competition from Sèvres porcelain drove the Meissen factory into decline during the late 1700's. It continued to operate but did not make wares of the same artistic quality.

English porcelain. England is well known as the center for the production of bone china. Before the invention of bone china, the English manufactured fine soft-paste porcelain at Chelsea, Bow, and Derby. Most of this English porcelain was styled after Oriental and Continental designs.

Worcester porcelain, first produced in 1751, is one of the oldest and best English porcelains. During its early years, the Worcester factory produced soft-paste porcelain, much of it decorated with Chinese designs in blue underglaze. Since the 1760's, it has manufactured bone china in a wide variety of colors and patterns.

Josiah Spode developed a bone china paste that became the standard English paste in 1800. Spode china featured a large number of designs but was especially noted for its exotic birds.

Most of the famous English Wedgwood ware is not porcelain at all, but earthenware or stoneware. Nevertheless, its classical Greek figures and reliefs became enormously popular and had a great influence on porcelain designs throughout Europe.

Modern porcelain. Technical advances enabled the porcelain industry to produce porcelain in large quantities. Today, extensive porcelain making is carried out in the United States, Europe, and Japan. Some notable examples of fine contemporary porcelain are American Lenox, German Rosenthal, and Japanese Noritake.

William C. Gates, Jr.

Related articles in *World Book* include:

Böttger, Johann F.
Ceramics
Cobalt
Doll (Porcelain dolls)
Dresden china
Enamel
Feldspar
Kaolin
Pottery
Wedgwood ware

Porcupine, *PAWR kyuh pyn,* is an animal that has long, soft hairs and strong, stiff quills on its back, sides, and tail. Porcupine quills are long, sharp bristles of hairs that are *fused* (grown together). Porcupines defend themselves by striking attackers with their quilled tails. The quills come out easily and stick into the attacker's flesh. The porcupine grows new quills to replace the ones lost. Porcupines cannot shoot quills at their enemies, as some people believe. In some kinds of porcupines, the tip of each quill is covered with tiny,

backward-pointing projections called *barbs.* The barbs hook into the flesh, and the quills are difficult to remove. Porcupine victims may die from infections caused by germs on the quills, or from damage to a vital organ. Quills may even stick in an attacker's jaw, making the animal unable to open its mouth and causing starvation. *Fishers,* large members of the weasel family, attack porcupines by flipping them over onto their backs.

Porcupines are *rodents* (gnawing animals). Biologists classify them as *Old World porcupines* and *New World porcupines.* Old World porcupines live in Africa, southeastern Asia, India, and southern Europe. Most kinds of Old World porcupines grow about 3 feet (91 centimeters) long, including the tail. They make their homes in tunnels in the ground and do not climb trees.

New World porcupines live in North and South America. These animals spend much time in trees. Several South American porcupines, called *coendous,* can even hang by their tails. Only one kind, the *North American porcupine,* lives in North America. North American porcupines are about 3 feet (91 centimeters) long and weigh about 20 pounds (9 kilograms). Their yellowish-white quills are 2 to 3 inches (5 to 8 centimeters) long. Their fur is brownish-black. North American porcupines live chiefly in forests of *coniferous* (cone-bearing) trees, such as pines and firs. They eat green vegetation and tree bark. They often climb trees to strip the bark from the upper part of the tree. They may kill a tree in this way.

Female North American porcupines give birth to a single offspring in the spring. The babies have quills at birth. North American porcupines are often incorrectly called *hedgehogs.* True hedgehogs live only in the Eastern Hemisphere. The flesh of the North American porcupine is edible, but few people consider it tasty.



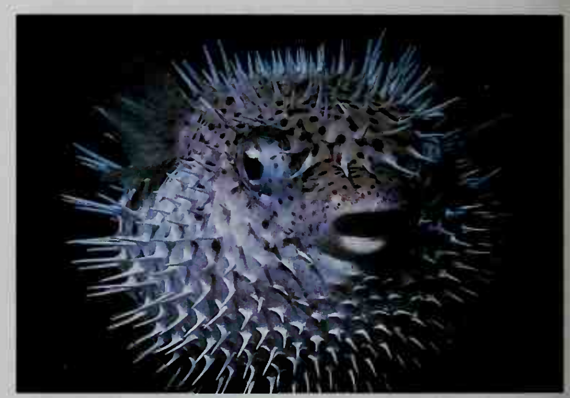
Leonard Lee Rue III, Bruce Coleman Ltd.

The North American porcupine is protected by yellowish-white quills. Its food includes tree bark.

Scientific classification. Old World porcupines make up the family Hystricidae. New World porcupines make up the family Erethizontidae. North American porcupines are *Erethizon dorsatum.* Hugh H. Genoways

See also **Animal** (picture: Animal defenses and weapons).

Porcupinefish, also called *spiny puffer,* is a kind of fish that has sharp, protective spines covering its body. When an enemy or intruder scares a porcupinefish, the fish may enter a hole or crack in a rock and fill its stomach with water. The water causes the fish to puff up like a balloon and makes its spines stick out. If taken out of the water, the porcupinefish puffs up by filling its stomach with air. In most species, the spines lie flat against the body when the fish are calm.



© David Hall, Photo Researchers

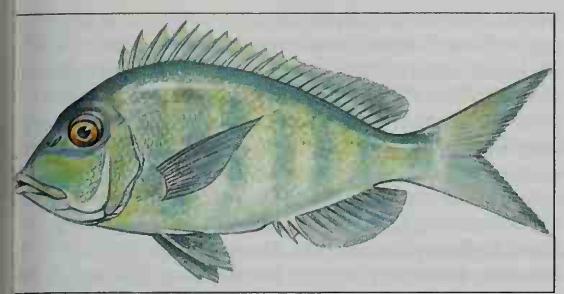
A porcupinefish has strong, sharp spines on its body. It fills its stomach with water to make the spines stick out.

There are 15 species of porcupinefish. Most are bluish, brownish, grayish, or greenish with yellow or white bellies. Some species have round black or brown spots. Porcupinefish grow to an average length of 10 to 12 inches (25 to 30 centimeters). All porcupinefish have two large teeth, one upper and one lower, that stick out like a beak. They use their teeth to feed on sea urchins, small crabs, and other hard-shelled prey. Porcupinefish live in tropical seas.

Scientific classification. Porcupinefish make up the porcupinefish family, Diodontidae. Leighton R. Taylor, Jr.

See also **Fish** (picture: The porcupinefish).

Pore is the tiny opening of a skin gland. The glands are like little sacks set deep in the skin. The cells inside the sacks produce sweat if the gland is a sweat gland, and oil if it is a sebaceous gland. The face has many sebaceous glands. The oil that these glands produce is normally a liquid. *Blackheads* form if the oil *cakes* (becomes solid) within the pores. If the skin around the blackheads becomes inflamed, acne pimples result. If certain kinds of bacteria get into the pores, they cause boils. A skin rash known as *prickly heat* develops when sweat glands are blocked up. See also **Acne; Perspiration; Prickly heat; Skin.** Paul R. Bergstresser



WORLD BOOK illustration by John F. Eggert

The jolthead porgy lives in Atlantic coastal waters.

Porgy, *PAWR gee,* is a fish that lives in shallow areas of warm seas. The body of a porgy is oblong and has flattened sides. Most porgies are silvery in color. Porgies are good food fish. They are caught both for sport and for commercial use.

There are more than 100 species of porgies. Several of them live along the coasts of North America. The *jolthead porgy* is probably the best known of these. It lives in the Caribbean Sea and in the Atlantic Ocean from Brazil to New England. The jolthead also is one of the largest porgies. It grows to a length of 2 feet (60 centimeters) and weighs 8 to 10 pounds (3.6 to 4.5 kilograms). John E. McCosker

Scientific classification. Porgies belong to the porgy family, Sparidae. The jolthead porgy is *Calamus bajonado.*

Porifera. See **Sponge.**

Pork is the meat from hogs. People throughout the world eat more pork than any other kind of meat. In the United States, pork ranks third in popularity, behind chicken and beef. Americans eat an average of 61 pounds (30 kilograms) of pork per person annually.

Pork is sold to consumers as fresh meat or in the form of *processed meats.* Processed meats are *cured* (treated) with a solution of salt and a chemical called sodium nitrite and then are smoked, baked, or dried. Curing and smoking give these meats a special flavor and help keep them from spoiling quickly or losing their color. The chief processed meats produced from pork are bacon, ham, and sausage. Fresh cuts of pork include pork chops, roasts, and spare ribs.

Pork contains many *nutrients* (nourishing substances) needed by the human body. It is an excellent source of vitamins, especially *thiamine* (vitamin B_1). The protein in pork provides the *amino acids* needed to build and maintain body tissue (see **Amino acid**). Pork also contains such essential minerals as copper, iron, phosphorus, and zinc. Pork fat is a good source of energy and of certain *fatty acids* the body cannot produce (see **Fat**).

Fresh pork sometimes contains the *larvae* (young) of a microscopic worm called *trichina.* A person who eats live trichina larvae may develop a disease called *trichinosis.* Thoroughly cooking fresh pork kills any trichina larvae that the meat may contain. Larry L. Borchert

Related articles in *World Book* include:

Bacon	Hog	Meat	Sausage
Ham	Lard	Meat packing	Trichina

Pork barrel is an American slang expression for a government treasury. It originated in the 1800's, when the word *pork* became slang for government money spent on local projects. At that time, farmers preserved pork by keeping it salted in barrels, and so bills distributing this money were called "pork barrel bills."

A legislator customarily votes for expenditures in other districts, even though he or she may think them unnecessary, to have legislators from those districts vote for projects in his or her district (see **Logrolling**). Defenders of this system point out that pork-barrel projects, such as river and harbor improvements, increase the country's wealth by providing more public facilities. However, excessive pork-barrel practices have led to movements to give the president of the United States the power to veto individual items in a spending bill without killing the whole bill. In 1996, Congress enacted a law that gave the president such a power beginning in 1997. But the Supreme Court of the United States ruled the law unconstitutional in 1998. Peter Woll

See also **Veto.**

Pornography. See **Obscenity and pornography.**

Porosity, *paw RAHS uh tee,* is the existence of many small holes or spaces in a material. In some porous materials, such as charcoal, earthenware pottery, and sponges, these holes connect. Gases and liquids can pass through the holes. In other porous materials, the small spaces inside are separated from each other by solid material. Bricks and certain types of foam rubber are examples of this kind of porous material. These materials are usually able to absorb liquids and gases.

Porosity is desirable in some materials and undesirable in others. For example, porous filters of charcoal can remove impurities from the air. However, porosity in iron castings reduces the strength of the metal.

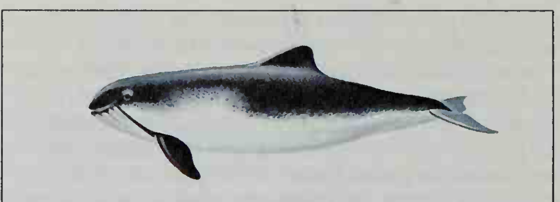
On the atomic scale, every material is considered porous because there is much free space between their atoms or molecules. For example, the spaces between the atoms of the metal palladium are large enough for hydrogen atoms to move about. John B. Butt

See also **Diffusion; Molecule.**

Porphyry, *PAWR fur ree* (A.D. 232 to 233-305?), was one of the leaders in the Neoplatonic school of philosophy. He was the student of Plotinus, the most important Neoplatonist, and published an edition of Plotinus's *Enneads* and a *Life of Plotinus.* Porphyry wrote a great many works but most have been lost or survive only as fragments. He wrote commentaries on works of Plato and Aristotle and his commentary on Aristotle's *Categories* became a standard medieval textbook on logic. Porphyry was born in Syria, studied in Athens, and became a disciple of Plotinus in Rome in 262 to 263. See also **Neoplatonism; Plotinus.** Carl A. Huffman

Porpoise is the name of several sea mammals closely related to dolphins. Porpoises look much like dolphins but are smaller in size. They also differ from dolphins in the shape of the head and teeth. Porpoises have a gently sloping forehead, a rounded snout, and spade-shaped teeth. Dolphins have a steeply sloping forehead, a beaklike snout, and cone-shaped teeth. Porpoises, dolphins, and whales make up a group of mammals called *cetaceans* (pronounced *suh TAY shuhnz*). Scientists classify porpoises, dolphins, and certain whales as a group of cetaceans called *toothed whales.*

Porpoises generally roam cool, coastal waters of the Pacific and Atlantic oceans. They can swim at speeds of about 12 miles (20 kilometers) per hour. They eat small fish and squid. Porpoises usually grow from 4 to 7 feet



WORLD BOOK illustration by James Teason

The harbor porpoise, also called the *common porpoise,* has a dark gray to black back and a pale gray or white belly. It lives primarily in cool coastal waters in the Northern Hemisphere.

(1.5 to 2.1 meters) in length and weigh from 110 to 220 pounds (50 to 100 kilograms).

There are six species of porpoises. The *harbor* or *common porpoise* and the *gulf porpoise* are dark gray to black on the back and pale gray or white on the sides and belly. The *finless porpoise* and *Burmeister's porpoise* are almost entirely gray or black. The *spectacled porpoise* and *Dall's porpoise* have a striking pattern of black and white. Most porpoises have a thick body and a small *dorsal fin* (back fin). Only the finless porpoise lacks a dorsal fin.

Human fishing activities have severely reduced the world's porpoise population. The Gulf of California harbor porpoise is an endangered species because so many have been trapped and accidentally killed in nets set for fish. Similarly, huge nets called *drift nets* have killed tens of thousands of Dall's porpoises. To protect porpoises and other marine life, many countries have agreed to stop using drift nets in ocean waters.

Daniel K. Odell

Scientific classification. Porpoises belong to the family Phocoenidae in the order Cetacea. Burmeister's, common, gulf, and spectacled porpoises belong to the genus *Phocoena.* Burmeister's porpoise is *P. spinipinnis,* the common porpoise is *P. phocoena,* the gulf porpoise is *P. sinus,* and the spectacled porpoise is *P. dioptrica.* Dall's porpoise is *Phocoenoides dalli.* The finless porpoise is *Neophocaena phocaenoides.*

See also **Dolphin; Whale** (Kinds of toothed whales).

Port is a place where ships and boats load and unload passengers and cargoes. Large, bustling ports have buildings and equipment for receiving, storing, and reshipping goods. Such facilities include wharves, warehouses, tugs, ferries, mechanical loaders and unloaders, and railroad and truck transportation (see **Ship** [Modernization of ports]).

Some ports, such as Cherbourg, France, and Rio de Janeiro, Brazil, stand on natural harbors formed by bays and inlets. Others, such as Los Angeles and Genoa, Italy, are built on artificial harbors protected by breakwaters and jetties. Many great ports lie on rivers far from the sea. Inland ports include London; Montreal; New Orleans; and Bordeaux, France.

Ports may also be classified by their purpose or function. For example, Gibraltar is a naval, or strategic, port. Concarneau, France, is a fishing port. Cape Town, South Africa, serves as a fuel-storage port for ships sailing around the tip of Africa. Kharg Island, Iran, in the Persian Gulf, is a leading petroleum port.

Much United States and Canadian commerce passes through ports on the Great Lakes. Inland waterways make it possible for all but the largest ocean ships to sail from the Atlantic Ocean to Chicago, Toronto, and other Great Lakes ports. Among the chief U.S. ports are Baltimore; Baton Rouge, Louisiana; Charleston, South Carolina; Houston; Long Beach, California; Los Angeles; New Orleans; New York City; Norfolk, Virginia; and Philadelphia. The main ports in Canada include Montreal, Quebec; Sept-Îles, Quebec; Thunder Bay, Ontario; and Vancouver, British Columbia. John F. Wing

See also **Free trade zone; Port of entry.**

Port Arthur, China. See **Lüshun.**

Port Arthur, Ontario. See **Thunder Bay.**

Port-au-Prince, *pawrt oh PRIHNS* (pop. 738,342), is the capital and largest city of Haiti. It lies on the Golfe de la Gonâve (Gulf of Gonave) on Haiti's west coast. For location, see **Haiti** (map).

People from many parts of Haiti sell produce and other goods in Port-au-Prince on sidewalks and in a large marketplace called the Iron Market. Factories produce such goods as cement, processed foods, rum, and textiles. Port-au-Prince has two cathedrals, a university, and many government buildings. It also has large slum areas, where overcrowded and unsanitary conditions reflect the poverty of many residents.

Port-au-Prince was founded in 1749 by French sugar cane planters. France controlled the city until 1804, when Haiti gained independence. Gary Brana-Shute

See also **Haiti** (pictures), **West Indies** (picture: A crowded street market).

Port Authority of New York and New Jersey is a self-supporting corporate agency of the states of New York and New Jersey. It was formed in 1921 to plan and develop terminal and transportation facilities, and to improve and protect the commerce of the port district. The district includes an area of both states within a 25-mile (40-kilometer) radius of the Statue of Liberty. The authority's facilities include bridges, tunnels, marine and inland terminals, airports, heliports, and a rail rapid transit system.

The Port Authority has 12 commissioners—6 from New Jersey and 6 from New York. Each is nominated by his or her state's governor and approved by its senate. The commissioners serve without pay for terms of six years. The Port Authority appears before the Federal Maritime Commission in the interest of the port area. The authority has trade development offices in Chicago, Cleveland, London, New York, and Tokyo. These offices promote commerce through the Port of New York.

Robert E. Paaswell

Port Elizabeth (pop. 303,353; met. area 825,799) is a leading seaport and industrial city in South Africa. It lies on the southern coast of South Africa (see **South Africa** [map]). Products manufactured in Port Elizabeth include automobiles and rubber.

The land that is now Port Elizabeth was once farmed by Xhosa people. Today, Xhosa people form the city's largest African group. The first large group of English settlers to reach South Africa landed at Port Elizabeth in 1820. They settled in and near Grahamstown, northeast of the city. Bruce Fetter

Port Louis, *LOO ihs* or *LOO ee* (pop. 138,482), is the capital, largest city, and leading port of Mauritius, an island country in the Indian Ocean. Port Louis lies in a lowland on the northwest coast of the country's main island, which is also called Mauritius. For location, see **Mauritius** (map). The city's main employers are textile

manufacturers, food-processing plants, shipping companies, and the government. Much sugar, the chief product of Mauritius, is exported from Port Louis.

France ruled Mauritius during the 1700's. The French governor founded Port Louis in 1736 and named it for Louis XV, the king of France. French culture still plays an important part in the city's life. Bruce Fetter

Port Moresby, *MOHRZ bee* (pop. 152,100), is the capital and largest city of Papua New Guinea, a country in the South Pacific Ocean. The city lies on a well-protected harbor on the southeastern coast of the island of New Guinea. For location, see **Papua New Guinea** (map).

Papua New Guinea's national government employs many of Port Moresby's people. The city has an international airport and a university and other training institutions. Important industries in Port Moresby include construction and food processing.

Port Moresby was established by the British shortly after British explorer John Moresby reached the site in 1873. During World War II (1939-1945), it served as an Allied military base and was bombarded by Japanese forces. The city had fewer than 5,000 people before the war but has since grown rapidly. David A. M. Lea

See also **New Guinea** (picture); **Papua New Guinea** (picture).

Port of entry is any place established by a government to receive aliens, imports, and customs duties. Customs officers admit all imported goods, collect duties, and enforce the customs and navigation laws. A person who unloads foreign goods at a port that does not have a custom house is guilty of smuggling.

Ports of entry may include seaports, lakeports, and airports situated at the borders or throughout the country. A custom house may be located wherever goods of other countries are held until they are distributed to local trade. Robert M. Stern

Port-of-Spain (pop. 59,649) is the capital and trade center of Trinidad and Tobago, an island country that lies off the northeast coast of Venezuela. The city lies near the foothills of the Northern Range of mountains on the island of Trinidad (see **Trinidad and Tobago** [map]).

The city's deep, sheltered harbor helps make it the port through which most of Trinidad's exports and imports are handled. Port-of-Spain also serves as the country's main commercial and industrial center. The city's architecture and other cultural features reflect the variety of its African, Asian Indian, and European ethnic heritage. The city was founded about 1560 by Spanish colonists. Gerald R. Showalter

See also **Trinidad and Tobago** (picture).

Port Royal. See **Annapolis Royal; Canada** (National historic sites).

Port Said, *sah EED* (pop. 460,000), is an Egyptian city that lies at the junction of the Suez Canal and the Mediterranean Sea. For location, see **Egypt** (political map). Its name in Arabic is *Bur Said.*

Port Said was founded in 1859 as a camp for workers who built the Suez Canal. After the canal opened in 1869, the city became one of the world's busiest ports. The canal was closed during the Arab-Israeli War of 1967, and the city lost its importance as a port. Egypt reopened the canal in 1975 and set up a free trade zone to encourage trade there (see **Free trade zone**). Products of Port Said include leather, refined petroleum, salt, and textiles. Robert L. Tignor

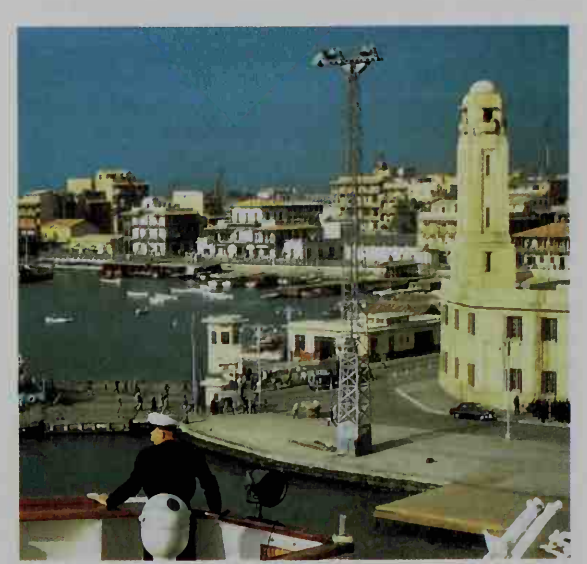
Port Sudan, *soo DAN* (pop. 206,727), is the main port of Sudan. It lies in northeast Sudan on the coast of the Red Sea (see **Sudan** [map]). Port Sudan was founded in 1906. It is a major commercial and shipping center, with a fine harbor and modern docking facilities. Most of Sudan's foreign trade moves through the port. Exports from Port Sudan include beans, cattle, cotton and cottonseed, gum arabic, hides, oilseeds, and sheep. Heavy machinery and manufactured products are among the chief imports. Kenneth J. Perkins

Portage is the carrying of goods or boats overland between two bodies of water, or around some obstacle such as a waterfall or river rapids. The term *portage* is also used for the land route over which the goods are carried. North American Indians traveled long distances by portaging between rivers and lakes. The Indians traveled as far upstream as their boats could go. The Indians then carried their canoes and goods overland to the next stream or lake, where they resumed the trip by water.

Portage la Prairie, Manitoba (pop. 12,976), serves as the market city for the surrounding *Portage Plains* farming region. For the location of the city, see **Manitoba** (political map). Portage la Prairie ranks as one of Manitoba's largest retail centers. The city received its name from an old *portage* (route between two bodies of water) used by fur traders.

Settlement in the area began in 1738, when French traders built Fort La Reine there. Permanent settlement at the site of the present city began in 1851. In 1868, the English-born land developer Thomas Spence organized the settlement into a colony called Manitobah. Portage la Prairie became a town in 1880, when the Canadian Pacific Railroad arrived. The town achieved city status in 1907. J. M. Bumsted

Porter, Cole (1891-1964), was an American songwriter famous for his witty lyrics and for imaginative melodies.



Photri from Marilyn Gartman

Port Said is one of Egypt's busiest ports. It lies at the junction of the Suez Canal and the Mediterranean Sea.

Porter's most popular songs are sophisticated, satirical, and sometimes silly. They include "Begin the Beguine," "Night and Day," "I've Got You Under My Skin," "Anything Goes," "Love for Sale," and "You're the Top."

Cole Albert Porter was born in Peru, Indiana. He showed an early talent for music and had a song published when he was only 11 years old. Several more of his songs were published while he was a student at Yale and Harvard universities.

In 1920 and 1921, Porter studied music in Paris. His experiences there provided him with the material for *Paris* (1928), his first Broadway success. He used the life of wealthy people as the theme for many of his musicals. These shows include *Fifty Million Frenchmen* (1929), *Gay Divorce* (1932), and *Anything Goes* (1934).

In 1937, Porter injured his legs severely in a horseback-riding accident. He used a wheelchair for the rest of his life but, despite constant pain, wrote many more successful musicals. Among them were *Du Barry Was a Lady* (1939), *Panama Hattie* (1940), *Mexican Hayride* (1944), *Kiss Me, Kate* (1948), *Can-Can* (1953), and *Silk Stockings* (1955). He also wrote the scores for the motion pictures *Born to Dance* (1936), *Rosalie* (1937), and *High Society* (1956). Ken Bloom

Porter, David (1780-1843), was a United States naval officer who fought in the War of 1812. He was captain of the *Essex,* which operated in the Pacific Ocean and was the first warship to fly the U.S. flag in those waters. In the war, Porter almost entirely destroyed the British whaling industry in the Pacific. Porter's informally adopted son, David G. Farragut, who later became the Navy's first admiral, also made the voyage (see **Farragut, David Glasgow**). Later, Porter surrendered to the British ships *Cherub* and *Phoebe.* He returned home as a hero and in 1815 became a Navy commissioner.

In 1823, Porter resigned this post to lead an expedition against pirates in the West Indies. When one of his officers was insulted at Fajardo, Puerto Rico, Porter forced Puerto Rican officials to apologize. As a result, a court-martial in 1825 found him guilty of disobeying orders and suspended him for six months. He resigned and served from 1826 to 1829 with the Mexican Navy, which he helped reorganize. Porter returned to the United States in 1829 and was appointed U.S. consul general to Algiers. He later served as a diplomat in Turkey.

Porter was born in Boston. At the age of 18, he joined the U.S. Navy as a midshipman. His son David Dixon Porter was also a noted U.S. naval officer (see **Porter, David Dixon**). Michael J. Crawford

Porter, David Dixon (1813-1891), was a United States naval officer who became noted for his service during the American Civil War (1861-1865). In the Union attack on New Orleans in 1862, Porter directed a mortar squadron under the command of his adopted brother, David Farragut. Porter fired mortar shells at Fort Jackson and Fort Saint Philip for five days. Then Farragut went past the forts and destroyed the Confederate fleet. The forts surrendered to Porter a few days later.

Later in 1862, Porter commanded the U.S. Navy's upper Mississippi squadron. In 1863, he helped the Army capture the Arkansas Post, also called Fort Hindman, in Arkansas. In addition, he aided in the siege of Vicksburg, Mississippi, and became a rear admiral for this action. Porter became commander of the North Atlantic Blockading Squadron in 1864. The squadron captured many merchant ships that tried to enter or leave Southern ports. In 1865, as commander of about 60 naval vessels, the largest fleet assembled during the war, Porter took part in the capture of Fort Fisher, North Carolina.

Porter served as superintendent of the U.S. Naval Academy from 1865 to 1869. He became a vice admiral in 1866. In 1870, he succeeded Farragut as an admiral, becoming the second person in the history of the Navy to hold that rank. Porter headed the Board of Inspection from 1877 until his death.

Porter was born in Chester, Pennsylvania. At the age of 10, he went with his father, David Porter, to fight pirates in the West Indies. He also served with his father as a midshipman in the Mexican Navy (see **Porter, David**). At the age of 16, Porter joined the U.S. Navy as a midshipman. He commanded the vessel *Spitfire* during the Mexican War (1846-1848). John F. Marszalek

Porter, Fitz-John (1822-1901), an American soldier, became the central figure in a celebrated military inquiry during the American Civil War. In August 1862, as a major general, Porter commanded a Union corps in the second Battle of Bull Run (also called Manassas). The corps was part of an army led by General John Pope. During the battle, Porter refused to obey Pope's order to attack Confederate forces. Porter believed such an attack would destroy the Union army. The Union forces eventually lost the battle, and Pope charged Porter with disobedience, disloyalty, and misconduct. In January 1863, a court-martial found Porter guilty and dismissed him from the army, though the evidence was confused and the fairness of the trial questionable. Porter had pleaded innocent. In 1879, a board of officers reopened the case and ruled in Porter's favor. The United States Congress restored Porter's rank in 1886.

Porter was born in Portsmouth, New Hampshire. He graduated from the U.S. Military Academy in 1845. James E. Sefton

Porter, Katherine Anne (1890-1980), was an American writer noted mainly for her short stories. Her *Collected Stories* (1965) won the 1966 Pulitzer Prize for fiction. Porter's most famous stories express political and social liberalism. Many contain religious symbolism, reflecting her Roman Catholic background. She made the setting for most of her short stories in a specific place, such as the American South, Mexico, or Europe.

Porter's major collections are *Flowering Judas* (1930); *Pale Horse, Pale Rider* (1939), a collection of three short novels; and *The Leaning Tower* (1944). Her only novel, *Ship of Fools* (1962), is a moral allegory that describes an ocean voyage from Mexico to Germany during the early 1930's. The story reflects the social and political turmoil of that time. *The Collected Essays and Occasional Writings of Katherine Anne Porter* (1970) is a collection of nonfiction. Porter was born in Indian Creek, Texas, near Brownwood. Arthur M. Saltzman

Porter, William Sydney. See Henry, O.

Portland, Maine (pop. 64,249; met. area pop. 243,537), has one of the finest harbors on the Atlantic Coast and is closer to Europe than any other transatlantic port in the United States. It is the largest city in Maine and a leading industrial and commercial center. During World War II (1939-1945), Portland was the base for the North Atlantic Fleet of the U.S. Navy.

Portland lies on the southwest coast of Maine. The city covers about 21 square miles (54 square kilometers). It is built on a narrow peninsula with a maximum height of 187 feet (57 meters) above sea level. It overlooks Casco Bay to the east. The bay has many islands, some of which are part of Portland. Mount Washington and the other mountains of the Presidential Range, to the northwest, tower in the distance. Between these peaks and the coast is a network of lakes and valleys to which Portland is the eastern gateway. To the south is Old Orchard Beach, a long stretch of smooth sand. For Portland's monthly weather, see **Maine** (Climate).

Portland is the home of a branch of the University of Maine and schools for the deaf and blind. Museums in the city include the Portland Museum of Art and the Maine Historical Society Museum. Next to the historical museum is the old home of poet Henry Wadsworth Longfellow, who was born in Portland.

City hall, the Custom House, the Public Safety Building, and federal, district, and state courts are clustered together in the heart of Portland's downtown area. An auditorium in city hall contains one of the largest organs in the world. The organ was a gift from the publisher Cyrus H. K. Curtis, who was born in Portland. In the 1970's and early 1980's, the city's downtown area was revived as a center for shopping and services. The Old Port is a shopping area located near Portland's waterfront.

Portland has many small factories. Oil, fish, and dry goods such as scrap metal are among the leading products shipped from the port. Tankers bring oil to the port for the Portland-Montreal pipeline to Canada.

About 28 million tons (25 million metric tons) of products are shipped in and out of the harbor of Portland yearly, making it one of the chief ports on the Atlantic Coast. Passenger cruise ships also make regular stops at Portland's harbor.

Portland was founded in 1632. It was first called *Machigonne,* and later *Falmouth.* The settlement was destroyed twice by Indians. During the Revolutionary War in America (1775-1783), the British bombarded the port. In 1791, a lighthouse was erected at what is now the adjacent town of Cape Elizabeth. The lighthouse, called Portland Head Light, is standing today. A fire in 1866 ruined much of Portland, but it was soon rebuilt. A large number of Victorian-style buildings erected when the city was rebuilt have been preserved. In 1899, the city of Deering was annexed. In 1993, the Casco Bay island of Long Island seceded from Portland. Portland is the seat of Cumberland County and has a council-manager form of government. Linda R. White

See also **Maine** (picture).

Portland, Oregon (pop. 529,121; met. area pop. 1,918,009), is the state's largest city and its major center of industry and trade. It also is an important West Coast port. Portland is on Oregon's northern border, near the junction of the Columbia and Willamette rivers. For the location of Portland, see **Oregon** (political map). About 55 percent of Oregon's people live in the city's metropolitan area.

Two New England land developers, Asa L. Lovejoy of Boston and Francis W. Pettygrove of Portland, Maine, founded Portland in 1845. Both believed that a great port city would someday stand on the site. Lovejoy and Pettygrove each wanted the new settlement to be named for his own home city. To settle the matter, they flipped a coin. Pettygrove won.

Portland is known as the *City of Roses* because of its many public and private rose gardens. Roses thrive in Portland's mild, moist climate. For the monthly weather in the city, see **Oregon** (Climate).

The city. Portland, the county seat of Multnomah County, lies at the northern end of the fertile Willamette Valley. Mountains of the Coast Range rise 20 miles (32 kilometers) west of the city. The view to the east of Portland features snow-capped Mount Hood, about 50 miles (80 kilometers) away in the Cascade Range. Portland covers about 112 square miles (290 square kilometers), including 6 square miles (15 square kilometers) of inland water. Portland and Vancouver, Washington, form a metropolitan area with a land area of 5,028 square miles (13,022 square kilometers). The Portland-Vancouver and Salem metropolitan areas make up the Portland-Salem Consolidated Metropolitan Area. This area has a population of 2,265,223 and a land area of 6,954 square miles (18,011 square kilometers).

Portland's main shopping district lies on the west bank of the Willamette River. This downtown area includes the 40-story First Interstate Bank of Oregon Building, Oregon's tallest building. The nearby Civic Auditorium Forecourt and Fountain has waterfalls and wading pools.

About 93 percent of Portland's people were born in the United States. African Americans, American Indians, and people of East Asian ancestry make up about 14 percent of the population.

Economy. The more than 2,800 manufacturing plants in the Portland metropolitan area employ about half of the area's workers. Industries in the area make computers and electronic equipment, food products, lumber and wood products, machinery, paper products, textiles, and transportation equipment. Other manufacturing activities include food processing and metal processing. Portland is the center of finance and medicine for Oregon and southwestern Washington.

The Port of Portland handles more automobiles, grain, lumber, and other nonfluid cargo than any other port in the Pacific Northwest. The port handles about 28 million tons (25 million metric tons) of cargo annually. Portland also leads the Pacific Northwest in wholesale trade. Barge and cargo ship lines, rail freight lines, and passenger trains serve the city. Portland International Airport lies about 6 miles (10 kilometers) northeast of the downtown area. Portland has one daily newspaper, *The Oregonian.*

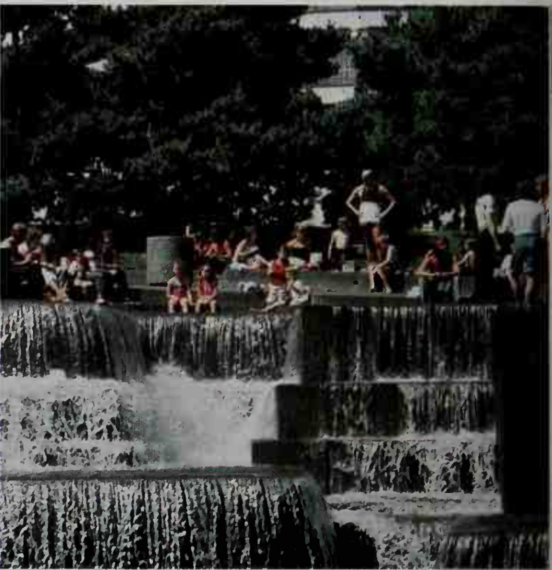
Education and cultural life. Portland's public school system includes more than 80 elementary and middle schools and 12 high schools. The city also has more than 170 parochial and private schools.

Portland State University, with more than 14,000 students, is the city's largest four-year institution of higher learning. Other colleges and universities in Portland include Lewis and Clark College, Reed College, the University of Portland, and Western States Chiropractic College. The Oregon Health Sciences University in Portland includes the state's medical and dental schools. The city's libraries include the main building and 14 branches of the Multnomah County Library.



D. C. Lowe, FPG

Portland is the largest city in Oregon and one of the West Coast's chief ports. The downtown business district, *above,* lies on the west bank of the Willamette River.



© Lee Poster, Bruce Coleman Inc.

Glistening waterfalls and wading pools help provide an attractive setting at the Civic Auditorium Forecourt and Fountain in downtown Portland.

Portland has a civic theater, a performing arts center, an opera company, and a symphony orchestra. The city's museums include the Oregon Historical Society, the Oregon Museum of Science and Industry, the Portland Museum of Art, and the World Forestry Center. Portland has 148 parks. Forest Park, a hilly, 6,000-acre (2,400-hectare) wilderness, ranks as the largest woodland within a U.S. city. The International Rose Test Gardens have won fame for the beauty and variety of their flowers.

Annual events in the city include the Rose Festival in June. The Portland Trail Blazers of the National Basketball Association play their home games in the Rose Garden arena.

Government. Portland has a commission form of government. The voters elect a mayor and four commissioners, all to four-year terms. Each of these five officials heads one or more departments of the city government. Together, they make up the City Council, which votes on city laws. Portland gets most of its revenue from business licenses and property and utility taxes.

History. Chinook Indians lived in what is now the Portland area before white people first arrived there. In 1829, a French-Canadian trapper named Etienne Lucier built the first log cabin in the Portland area. Two land developers from New England, Asa L. Lovejoy and Francis W. Pettygrove, founded Portland in 1845. In 1851, when Portland was incorporated, it had 821 people and was the largest town in the Pacific Northwest.

Portland grew steadily from 1850 to 1900. Settlers came by covered wagon to Portland and nearby farm areas. Portland became a trade center for fur, grain, lumber, canned salmon, and wool. In 1883, rail lines linked it with the East. The improved transportation encouraged the growth of manufacturing in the area.

Between 1900 and 1910, Portland's population grew from 90,426 to 207,214. The rural population of the Pacific Northwest also increased, providing new markets for Portland manufacturers. The city served as a supply point for gold miners in Alaska and the Yukon Territory of Canada during the late 1890's and early 1900's. A world's fair, the Lewis and Clark Centennial Exposition of 1905, brought 3 million visitors to Portland. Many of them settled in the city.

For many years, the lumber and wool products industries provided about two-thirds of Portland's jobs. But in 1933, a huge forest fire called the Tillamook Burn destroyed the city's main timber supplies. Many Portland sawmills closed permanently after this fire, which swept across nearby Tillamook County.

In the 1930's, new dams on the Columbia and Willamette rivers provided cheap electricity for Portland. As a result, many industries that depended on electricity came to the city. They included metal processing and the manufacture of metal products. In the early 1940's, during World War II, shipbuilding and other war-related industries brought nearly 100,000 people to the city. Many of these people stayed after the war ended in 1945. In 1950, Portland had a population of 373,628.

By 1960, parts of central Portland had become rundown. Urban renewal projects during the 1960's replaced many old structures near the downtown area with apartment and office buildings. Portlanders also became concerned about pollution of the Willamette River. By 1972, efforts by industry and the federal, state, and city governments had made the Willamette in south Portland clean enough for swimming.

In 1972, air pollution and parking problems in the central business district of Portland led to adoption of the Downtown Program. A number of projects were carried out as part of the program to reduce congestion and preserve the downtown area. These projects included the construction of parking garages and the widening of some sidewalks. Another part of the program,

the Portland Transit Mall, was completed in 1977. This open mall serves as a center for the city's bus traffic. The Downtown Program also included the River Place residential and commercial development on the Willamette River, the Pioneer Place office and shopping mall in downtown Portland, and the Oregon Convention Center in southeast Portland.

The 11-mile (18-kilometer) Metropolitan Area Express (MAX) rail line, completed in 1986, links downtown Portland with the Oregon Convention Center and the suburb of Gresham. A second line linking downtown Portland with the western suburbs was completed in 1998.

Between 1950 and 1980, the population of Portland declined slightly, but the metropolitan area population increased. In the 1980's and 1990's, the city's population rose again, reaching 529,121 by 2000. The metropolitan area population continued to grow. Robert J. Caldwell

See also **Architecture** (picture: Postmodernism); **Oregon** (pictures).

Portland cement. See **Cement and concrete.**

Porto, *PAWR too* (pop. 302,467), is Portugal's second largest city. Only Lisbon is larger. Porto is also called Oporto (pronounced *oh PAWR toh*). It is one of the country's chief seaports and serves as the commercial and industrial center of northern Portugal. It lies on the Douro River, 3 miles (5 kilometers) from the Atlantic Ocean. For location, see **Portugal** (political map). Porto is known for its role in processing and exporting Portugal's excellent port wines. The city also has food-processing plants, sugar refineries, textile mills, and other industries. Principal landmarks in Porto include the cathedral, which dates from the 1100's, and the bishop's palace, built during the 1700's. The Arrábida Bridge, one of three bridges across the Douro at Porto, is one of the longest concrete arch bridges in Europe. The University of Porto was founded in 1911.

Porto began as an ancient Roman trading community. During the 1700's, Porto's wine trade began to link the city closely with England. The struggle to establish a constitutional government for Portugal began in Porto in 1820. Douglas L. Wheeler

Pôrto Alegre, *PAWR too ah LEH grih* (pop. 1,386,828; met. area pop. 2,906,472), is the capital of the state of Rio Grande do Sul in Brazil. It is on the Guaiba River, at the head of the Patos Lagoon—an arm of the Atlantic Ocean (see **Brazil** [political map]). Its name means *Joyous Port.*

Pôrto Alegre is a major industrial and commercial center. A modern city, it has many skyscrapers. Its port can serve small ships. Meat, lumber, and tobacco from outlying rural areas are the city's chief exports. Pôrto Alegre's industries include brewing, tanning, meat packing, and wool processing. The city has many banks, other financial institutions, and universities.

Pôrto Alegre was founded in the 1740's by colonists from the Azores. In the 1800's, many German and Italian immigrants settled in the city. J. H. Galloway

Porto-Novo, *PAWR toh NOH voh* (pop. 144,000), is the official capital of Benin. However, most of the nation's government activity takes place in the nearby city of Cotonou. Porto-Novo lies in southeastern Benin on the lagoon of Porto-Novo, an inlet of the Gulf of Guinea in the Atlantic Ocean. For location, see **Benin** (map). Porto-Novo is a main trading center for goods produced in Benin. A railroad and Benin's chief river, the Ouémé, connect the city with the interior of the country.

Porto-Novo was probably founded in the 1600's by the Adja, a black African people. Later in the 1600's, the Portuguese founded a trading post in the city. Porto-Novo became a center of the slave trade in the 1770's. French colonial influence began in the mid-1800's. The city became a regional capital of French West Africa after that colony was established in 1904. When Benin gained independence from France in 1960, Porto-Novo became the capital. Immanuel Wallerstein

Porto Rico. See **Puerto Rico.**

Portobelo, *PAWR toh BEHL oh* (pop. 2,774), a village on the Caribbean Coast of Panama, was often attacked by English pirates of the 1600's and 1700's. The town was one of the chief Spanish trading centers in Latin America. Spanish ships sailed from Portobelo to Spain with treasures of Latin America. The Spaniards founded the town in 1597. Portobelo lost importance as a seaport after the early 1700's. Gary Brana-Shute

Portsmouth, *PAWRTS muhth,* a city on the southern coast of England, is the United Kingdom's chief naval center. It is the chief city in the district of Portsmouth, which has a population of about 174,700. For location, see **England** (political map).

Harbor facilities, dry docks, and ship repair basins line much of the waterfront in Portsmouth. Among the city's major industries are shipbuilding, engineering, and the manufacture of clothing, plastics, and pharmaceuticals. Portsmouth's landmarks include a cathedral that dates from the 1100's and the birthplace of the famous novelist Charles Dickens.

Portsmouth was founded in the 1100's. It became the leading naval station in England after the construction of a dockyard there during the 1500's. The dockyard declined in size and use after World War II ended in 1945.
Peter R. Mounfield

Portsmouth, *PAWRTS muhth* (pop. 20,784), is the chief seaport on the coast of New Hampshire. It is a commercial center of southeastern New Hampshire. Portsmouth and Rochester, New Hampshire, form a metropolitan area with 240,698 people. Portsmouth was founded as Strawbery Banke in 1630 and was incorporated as a city in 1849. It lies at the mouth of the Piscataqua River (see **New Hampshire** [political map]). The Portsmouth Naval Shipyard is nearby. The city has a number of corporate offices and financial institutions. Its attractions include Strawbery Banke, a restored historic area, and many houses dating from the 1700's or early 1800's. The city has council-manager government.
Robert L. A. Adams

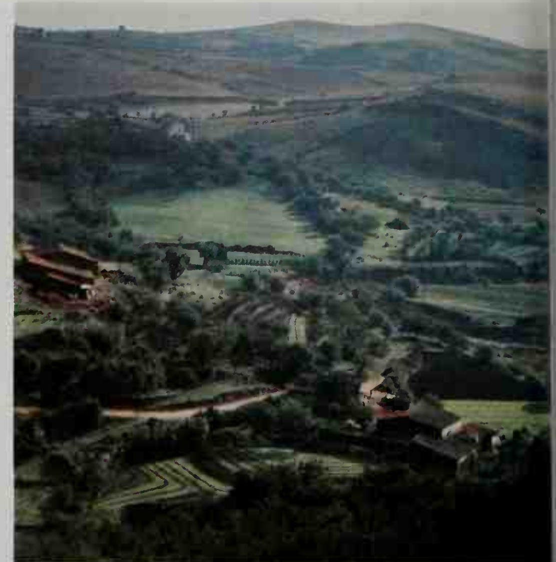
See also **New Hampshire** (picture: Strawbery Banke); **Portsmouth Naval Shipyard.**

Portsmouth Naval Shipyard, *PAWRTS muhth,* New Hampshire, occupies over 200 acres (81 hectares) on a group of connected islands in the Piscataqua River. The islands are within Maine, but the naval base uses nearby Portsmouth, New Hampshire, as its post office address. Commands at the base include a naval hospital, marine barracks, and naval disciplinary command.

Shipbuilding on the Piscataqua River dates from 1645, but the first ship built at the navy yard, established in 1800, was not launched until 1815. After World War I (1914-1918), the base specialized in submarine construction. W. W. Reid



Most of Portugal's people live in small fishing or farming villages. Here, a fishing crew braves the Atlantic Ocean.



Adeline Haaga, Tom Stack & Asso

Farmland, such as that seen here, covers much of the country. Portugal's crops include grapes, olives, and tomatoes. Wines made from Portuguese grapes are world famous.

Portugal

Portugal is the westernmost country of continental Europe. The small country lies on the Iberian Peninsula. Spain—Portugal's neighbor to the east and north—covers most of the peninsula. Western and southern Portugal face the Atlantic Ocean. Lisbon is Portugal's capital and largest city.

Most Portuguese live in rural villages. The villagers include skilled people who brave the rugged Atlantic waters to fish in small boats and farmers who grow grapes that are used to make fine wine. Fish and wine from Portugal are enjoyed by people in many parts of the world.

During the 1400's and 1500's, daring Portuguese explorers launched the great age of European exploration. Bartolomeu Dias commanded the first European voyage around the Cape of Good Hope at the southern tip of Africa. Vasco da Gama sailed around the cape and discovered a sea route to Asia. Pedro Álvares Cabral sailed to what is now Brazil. These expeditions and other voyages led to the establishment of a vast Portuguese empire. This empire included colonies in Africa, Asia, and South America.

Portugal's power and influence began to weaken during the late 1500's. But the country held on to much of its empire for more than 400 years. In the 1960's and 1970's, however, all but three of its remaining overseas territories gained their independence. These three territories were the Azores and the Madeiras, Portuguese islands in the North Atlantic Ocean; and Macao, a tiny area located on the southern coast of China. In 1999, Portugal returned control of Macao to the Chinese.

Douglas L. Wheeler, the contributor of this article, is Professor of Modern History at the University of New Hampshire and the author of books about Portugal and Angola.

The 1970's brought about a major political change within Portugal. Dictators had ruled the country from 1926 to 1974. During this period, personal freedom was limited and opposition to the Portuguese government was crushed. In 1974, a group of young military officers staged a revolution and overthrew the country's dictatorship. Portugal adopted a democratic system of government in 1976.

Government

Portugal is a republic. Its Constitution, adopted in 1976, grants the people such rights as freedom of speech, religion, and the press. Portuguese citizens 18 years or older may vote in elections.

Facts in brief

Capital: Lisbon.
Official language: Portuguese.
Official name: República Portuguesa (Portuguese Republic).
Area: 34,340 mi² (88,941 km²), not including the Azores and Madeira island groups. *Greatest distances*—north-south, 350 mi (563 km); east-west, 125 mi (201 km). *Coastline*—458 mi (737 km).
Elevation: *Highest*—Estrela, in Serra da Estrela, 6,539 ft (1,993 m). *Lowest*—sea level.
Population: *Estimated 2002 population*—9,863,000; density, 287 per mi² (111 per km²); distribution, 52 percent rural, 48 percent urban. *1991 census*—9,862,540. Population figures include the Azores and Madeira island groups.
Chief products: *Agriculture*—grapes, tomatoes, potatoes, hogs, chickens, milk, beef cattle, corn. *Fishing*—sardines, tuna. *Manufacturing*—textiles, food products, paper products, electrical machinery, cork products, ceramics, shoes, cement, fertilizer.
National anthem: "A Portuguesa" ("The Portuguese").
Money: *Basic unit*—euro. One hundred cents equal one euro. The escudo, the former basic unit, was taken out of circulation in 2002.

National government. A parliament called the Assembly of the Republic makes Portugal's laws. It has 230 members. The members of the Assembly are elected by the people and serve four-year terms.

The people elect a president to a five-year term. The president may serve no more than two consecutive terms in office.

The president appoints a prime minister. The prime minister heads the government. The person chosen by the president for the office is usually the leader of the political party that has the most seats in the parliament. The prime minister chooses members of a Cabinet. The prime minister and the Cabinet carry out the operations of the government.

Local government. Portugal—including the Azores and Madeiras—is divided into 22 districts for purposes of local government. Voters in each district elect a governor and legislature to run the district government. Cities and towns within the districts also have local governments.

Politics. Portugal has a large number of political parties. Among the largest and most powerful parties in the country are the Social Democratic Party and the Portuguese Socialist Party. Portugal's other important political parties include the People's Party and the Unified Democratic Coalition.

Courts. The Supreme Court of Portugal is the highest court of appeal in the country. Portugal also has four lower courts of appeal and a variety of district and local courts.

Armed forces. About 54,000 people serve in Portugal's armed forces. The country has an army, navy, and air force. The armed forces include both volunteers and draftees. People who have finished their terms in the active military remain in the military reserves until age 35. Portugal's military reserves have about 210,000 members.

People

Population and ancestry. Lisbon, Portugal's capital, is also the country's largest city. The city is also the country's economic, political, and cultural center. Lisbon has one of the world's finest natural harbors. Porto is the country's only other large city. Porto is the major economic center of northern Portugal. About a third of the Portuguese people live in or near Lisbon and Porto. See **Lisbon; Porto.**

People called Iberians were the first known inhabitants of what is now Portugal. They lived there before the beginning of recorded history—about 5,000 years ago. Through the centuries, various other groups came to Portugal. They included Phoenicians, Carthaginians, Celts, Greeks, Romans, Visigoths, and North African Muslims.

Today's Portuguese people are a mixture of all the country's groups. Since the mid-1960's, thousands of black Africans from Portugal's former African colonies have moved to Portugal. They form the country's only minority group.

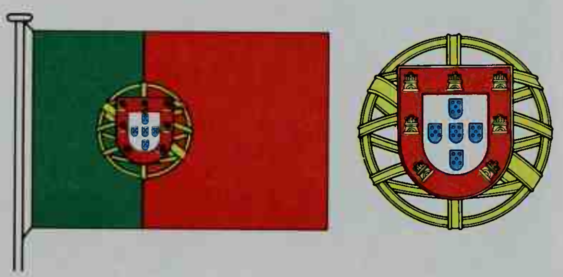
Way of life. Most rural Portuguese live in small fishing or farming villages. Fishing villages line the country's coast. The people of these settlements have long relied on fishing for their livelihood. They brave the rugged waters of the Atlantic Ocean in small boats to catch fish. Family members who stay home do such chores as cleaning the fish and mending the nets.

Portuguese farmers raise a variety of crops, but they are best known for their fine grapes that are used to make wine. Wines from Portugal are enjoyed by people in many parts of the world. Some Portuguese winemakers still follow the colorful old custom of crushing the grapes with their bare feet.

Although Portugal remains a rural country, its cities—especially Lisbon and Porto—are growing rapidly. Each year, a large number of the nation's rural people move to urban areas to find jobs in industry or other city activities. Portugal's cities have buildings that are hundreds of years old as well as modern apartment and office buildings.

The Portuguese maintain close family ties. Often, two or more generations of a family live together in the same house. Men and women who move to cities from villages tend to keep in close touch with their relatives back home.

Most Portuguese in both cities and rural areas wear clothing similar to that worn in Europe and the United States. But some rural people dress in styles similar to those of their ancestors. Berets, stocking caps, and baggy shirts and trousers are common among men. Many



Portugal's flag, *left,* has a band of green, which stands for hope; and of red, which symbolizes the blood of the country's heroes. Portugal's coat of arms appears on the flag and at the right. It shows castles and shields that recall Portuguese history.



Portugal lies in southwestern Europe. The Azores and Madeiras, two island groups to the west, are Portuguese territories.



Portugal map index

Districts*

District	Population		
Aveiro	667,690	C	2
Beja	162,950	F	3
Braga	767,500	B	2
Bragança	152,770	B	4
Castelo Branco	208,700	D	3
Coimbra	424,550	D	2
Évora	170,770	F	3
Faro	344,830	H	3
Guarda	183,240	C	3
Leiria	428,950	D	2
Lisboa	2,052,910	E	2
Portalegre	129,850	E	3
Porto	1,672,360	8	2
Santarém	441,440	E	2
Setúbal	725,160	F	2
Viana do Castelo	249,550	8	2
Vila Real	232,350	B	3
Viseu	399,440	C	3

Cities and towns

City or town	Population		
Abrantes	5,904	E	2
Albergaria-a-Velha†	22,310	C	2
Alcácer do Sal†	13,840	F	2
Alges*	18,396	F	2
Algueirao-Mem Martins*	37,381	F	1
Aljustrel	5,208	G	2
Almada	22,550	F	1
Almeirim*	10,038	E	2
Almodôvar†	8,710	G	2
Alverca do Ribatejo*	21,934	F	2
Amadora*	122,106	F	2
Amora*	7,122	F	2
Aveiro	32,847	C	2
Baixa da Banheira*	22,933	F	2
Barreiro	47,901	F	1
Beja	19,212	F	3
Braga	86,316	B	2
Bragança	15,624	B	4
Buraca*	13,836	F	2
Cacem*	55,342	E	1
Caldas da Rainha	21,070	E	1
Camarate*	5,302	F	2
Carnaxide*	13.317	F	1
Cascais	18,962	F	1
Castelo Branco	26,146	D	3
Castro Daire†	17,750	C	3
Castro Verde†	7,950	G	2
Chaves	11,708	B	3
Coimbra	89,639	D	2
Corroios*	10,549	F	2
Coruche†	22,790	E	2
Cova da Piedade*	24,906	F	2
Covilhã	21,836	D	3
Elvas	13,190	E	3
Entroncamento*	13,925	E	2
Ermezinde*	5,690	C	2
Espinho*	11,888	C	2
Estremoz	6,746	E	3
Évora	38,005	F	3
Fafe*	11.043	B	2
Faro	31,619	H	3
Fátima	4,921	D	2
Figueira da Foz	25,929	D	2
Gondomar*	20,622	B	2
Grândola†	12,990	F	2
Guarda	17,877	C	3
Guimarães	47,435	B	2
Ílhavo*	13,144	C	2
Lagos	11,746	H	2
Lamego	9,442	C	3
Laranjeiro*	23,086	G	3
Lavradio*	12,668	F	2
Leca de Palmeira*	15,605	C	2
Leiria	27,758	D	2
Linda a Velha*	25,012	F	1
Lisbon (Lisboa)	663,315	F	1
Lousã†	13,690	D	2
Macedo de Cavaleiros†	18,550	B	3
Maia*	25,885	B	2
Marinha Grande*	21,984	D	2
Matosinhos*	29,798	B	2
Mértola†	9,280	G	3
Mira†	13,460	C	2
Mirandela	7,862	B	3
Monchique†	6,650	G	2
Montemor-o-Novo	6,758	F	2
Montijo	23,247	F	2
Mora†	6,290	E	2
Moscavide*	14,497	F	2
Moura*	8,279	F	3
Nazaré	9,908	D	2
Niza†	9,300	E	3
Odemira†	25,370	G	2
Odivelas*	48,774	E	1
Oeiras*	10,277	F	1
Oleiros†	7,070	D	3
Olhão*	24,607	H	3
Oliveira*	20,645	C	2
Ovar	11,476	C	2
Pampilhosa da Serra	5,270	D	3
Parede*	11,744	F	1
Pedroso*	16,909	B	2
Penafiel	6,886	B	2
Penamacor†	7,640	D	3
Peniche	15,304	E	1
Pinhal Novo*	10,347	F	2
Ponte de Sor†	17,520	E	3
Pontinha*	13,407	E	1
Portalegre	15,383	E	3
Portel†	7,280	F	3
Portimão	16,786	H	2
Porto	302,467	B	2
Povoa de Santa Iria*	13,555	E	2
Povoa de Santo Adriano*	14,463	E	1
Póvoa de Varzim	23,851	B	2
Queluz*	42,885	E	1
Reguengos	5,214	F	3
Sacavem*	16,231	E	1
Salvaterra de Magos†	18,990	E	2
Santarém	23,678	E	2
Santo Tirso	12,321	B	2
São João da Madeira	18,452	C	2
São Mamede de Infesta*	17,464	C	2
São Martinho*	11,043	D	1
Senhora da Hora*	19,988	C	2
Serpa†	17,130	G	3
Setúbal	83,220	F	2
Sezimbra	7,320	F	1
Silves	6,048	G	2
Sines	9,772	G	2
Soure	21,150	D	2
Tavira	8,892	H	3
Tomar	14,022	D	2
Torres Novas*	9,802	E	2
Torres Vedras	13,394	E	1
Valbom*	13,343	C	3
Vendas Novas	8,481	F	2
Vialonga*	11,849	E	2
Viana do Castelo	9,007	B	2
Vila do Conde*	19,990	B	2
Vila Franca de Xira	17,191	E	2
Vila Nova de Gaia	68,302	C	2
Vila Real	13,809	B	3
Vila Real de Santo António	8,151	G	3
Vila Viçosa	5,048	E	3
Viseu	20,659	C	3

*Does not appear on map; key shows general location.
†Population is for the municipality, which may include rural areas as well as the urban center.
Source: 1994 official estimates.

women wear long dresses and shawls. In some places, the people dress entirely in black or another dark shade for everyday activities. But they put on brightly colored costumes for special occasions.

The chief foods of Portugal include beef, pork, chicken, fish (especially sardines), rice, and potatoes. A favorite dish is *bife com ovo a cavalo*—steak with French fried potatoes and an egg on top.

The people enjoy such recreational activities as folk songs, bullfights, and soccer. Portuguese bullfights differ from those of Spain and Latin America in a major way. In Spain and Latin America, the bulls are killed at the end of the bullfights. In Portugal, it is illegal to kill the bulls during the fights.

Language. Portuguese is the official, and the only widely used, language of Portugal. Like Spanish, it is one of the Romance languages that developed from Latin. Portuguese and Spanish are similar in many ways. See **Portuguese language**.

Religion. Most Portuguese who practice a religion are Roman Catholics. The country also has small groups of Jews, Muslims, and Protestants.

Until the early 1900's, the Roman Catholic Church was, in effect, part of Portugal's national government. The church and state were separated in 1911. But Catholicism remains important to the Portuguese, especially the rural people. In many rural areas, Catholic priests have major roles in local government, education, and social life. Traditional Catholic celebrations, processions, and pilgrimages are important activities for the people. Each year, thousands of people make a pilgrimage to the Portuguese town of Fátima. There, in 1917, the Virgin Mary reportedly appeared to three children who were tending sheep (see **Fátima, Our Lady of**).

Education. Portugal's educational system is weak compared to those of most other Western European nations. Many adults in rural areas cannot read or write. For Portugal's literacy rate, see **Literacy** (table: Literacy rates). By law, Portuguese children must attend school between the ages of 6 and 15. But many children leave school before 15. In most cases, they come from poor families and leave school to begin work. Elementary education is available throughout Portugal, but many parts of the country have no high schools.

Portugal has 20 universities, many of which were opened after the 1974 revolution. The largest one is Lisbon University.

The arts. The golden age of Portuguese art began in the 1400's, about the same time that the country became a world power. It lasted until the 1600's. The art of the golden age was influenced by the Catholic Church, the royalty, and the Portuguese love of the sea.

During the golden age, architects built many beautiful churches and artists decorated them with religious paintings and sculptures. These architects and artists developed a striking style noted for its elaborate use of decoration. The style is called *Manueline,* after King Manuel I, who ruled from 1495 to 1521 and sponsored many artists. A famous example of Manueline art is a church window frame at Tomar, shaped to resemble such marine items as coral, seaweed, and ship nets and ropes. Nuno Gonçalves, the best-known artist of the golden age, gained fame for fine paintings of saints, kings, and princes.



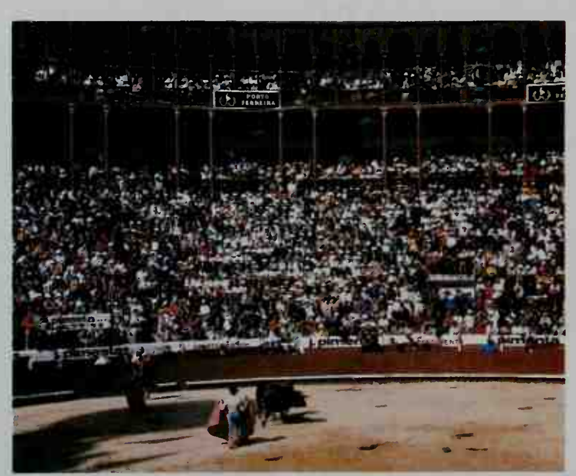
Claus Meyer, Black Star

Lisbon is Portugal's capital and its largest city. This busy, crowded city on the west coast of Portugal serves as the nation's economic, political, and cultural center.



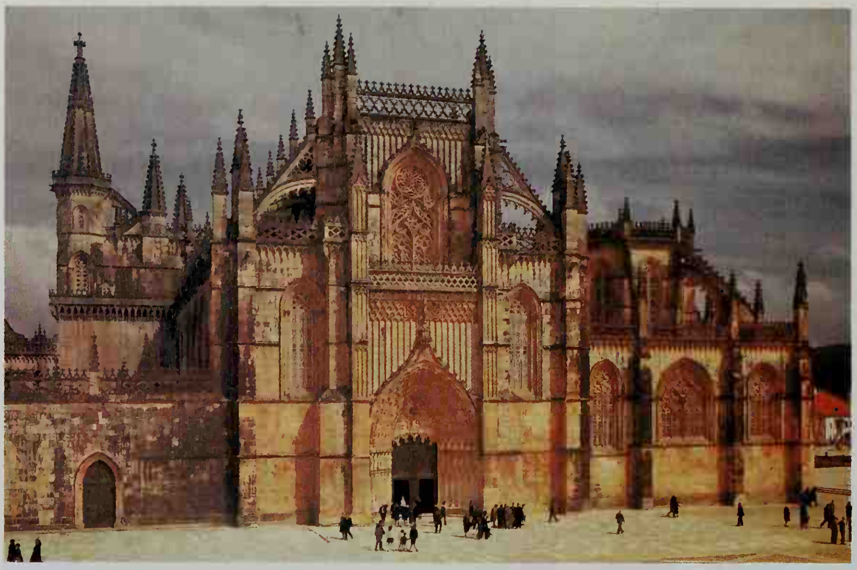
S. C. Bisserot, Bruce Coleman Inc.

An outdoor market in the small town of Loulé attracts shoppers seeking fresh fruits and vegetables. Many Portuguese farmers regularly sell crops at such markets.



J. Messerschmidt, Bruce Coleman Inc.

Bullfights attract huge crowds in Portugal. In Portuguese bullfights—unlike the bullfights of Spain and Latin America—it is illegal to kill the bull.



A Roman Catholic church i Batalha, *shown here,* is one o many magnificent churches built during the golden age o Portuguese art. Much Portuguese art and architecture during this period dealt with religious subjects.

Toni Schneiders, Bruce Coleman Inc.

The most famous literary work of the golden age was *Os Lusíadas* by Luiz de Camões. Published in 1572, this long epic poem praises Portugal's historical accomplishments and heroes.

After about 1800, religious art gave way to art that reflects everyday life. The Portuguese became known for their novels, poetry, and political cartoons. In 1998, Portuguese novelist Jose Saramago won the Nobel Prize for literature.

The Portuguese also have a wealth of folk art. Their folk songs range from lively dance music called *chulas* and *viras,* to *fados* (sad songs sung to the accompaniment of a guitar). Portuguese handmade pottery, lace, and linen are prized by people in many countries.

Land and climate

Portugal covers 34,340 square miles (88,941 square kilometers). This figure does not include the Azores or the Madeira Islands. The Azores cover 868 square miles (2,247 square kilometers), and the Madeiras cover 307 square miles (794 square kilometers). Most of Portugal is relatively flat and lies at a low altitude above sea level. But there are mountain ranges in northeastern, central, and southwestern Portugal.

Land regions. Portugal can be divided into four main land regions: (1) the Coastal Plains, (2) the Northern Tablelands, (3) the Central Range, and (4) the Southern Tablelands.

The Coastal Plains are flatlands that lie along and near the western and southern coasts. In some areas, the region is narrow, but in other places it extends into the center of the country. This region supports numerous farm and fishing villages. Portugal's main cities, Lisbon and Porto, lie on the Atlantic Coast in the region.

The Northern Tablelands, Central Range, and Southern Tablelands are extensions of the *Meseta,* a huge plateau that covers most of Spain. The regions consist mainly of plains broken by mountain ranges. Farmers grow crops and raise livestock on the plains. The mountains yield a high percentage of Portugal's minerals.

Portugal's highest mountains are in the Serra da Estrela range in the Central Range region. Peaks there rise more than 6,000 feet (1,829 meters) above sea level. Estrela, Portugal's highest mountain, rises 6,539 feet (1,993 meters) in the region.

Rivers. Two major rivers, the Douro and the Tagus, cross Portugal from east to west. The Douro, in the north, empties into the Atlantic Ocean at Porto. The Tagus, in the center of the country, flows into the ocean at Lisbon. The Guadiana, another important river, forms part of Portugal's boundary with Spain in the southeast.

The Tagus River divides Portugal in several ways. The area north of the river is much cooler than the area south of it. The northern area is heavily populated, while the south is thinly settled. Farms in the north tend to be small, but the south has many huge farms. In addition, the people north of the Tagus are generally more conservative politically than those south of the river. See Tagus River.

Climate. Portugal has a mild climate. The country receives much sunshine, especially in the south. Vacationers flock to resorts in the south to enjoy the warm, sunny climate there. In spring and summer, Portugal's weather is generally warm and dry, with little or no rain. In fall and winter, the weather is cool and heavy rains fall on much of the country. Southern Portugal receives no snow, but parts of the north receive a little. Snow generally covers the highest peaks of the Serra da Estrela range for several months each year.

Average temperatures in Portugal range from about 70 °F (21 °C) in July to about 50 °F (10 °C) in January. Average annual precipitation totals about 55 inches (140 centimeters) in parts of the inland north, but only about 20 inches (51 centimeters) in the coastal south.

Economy

Portugal ranks as one of the poorest countries in Europe. Since the 1960's, however, the country has generally experienced economic growth.

Until the mid-1900's, Portugal's economy was based



Physical features

Feature		
Cabo Carvoeiro (cape)	C	1
Cape St. Vincent	D	1
Cávado River	A	2
Douro River	A	2
Estrela (mountain)	B	2
Guadiana River	D	2
Minho River	A	2
Mondego River	B	2
Sado River	C	2
Serra da Estrela (mountains)	B	2
Serra de Alvelos (mountains)	B	2
Tagus River	C	2

chiefly on agriculture and fishing. Today, manufacturing is the most important single element in the economy. It accounts for about 30 per cent of Portugal's economic production. Agriculture and fishing together account for about 10 per cent. Service industries, taken together, account for about 60 per cent of the economic production.

Natural resources. Portugal has some valuable mineral resources, but—for the most part—these resources have not been well developed. The most important developed mineral resource is building stone, which is found throughout the country. Decorative marble is the most valuable type of building stone quarried in Portugal. Portugal also has deposits of coal, copper, and wolframite. Wolframite is used to make tungsten.

Forests cover about a third of Portugal. Large pine forests stand in the north. Forests of cork oak trees in central and southern Portugal yield large quantities of cork.

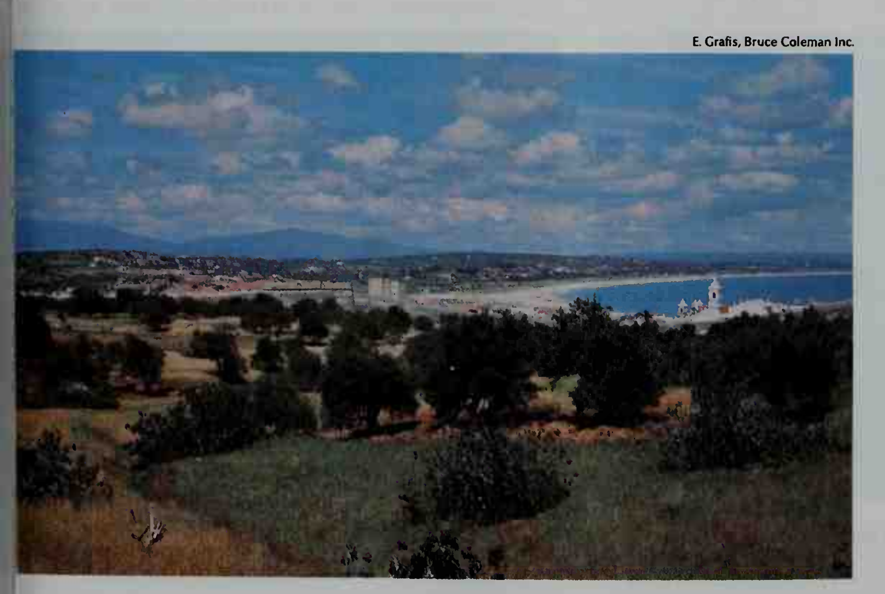
Portugal's rivers, especially the Douro and Tagus, provide hydroelectric power. The Atlantic Ocean is another important resource. Many Portuguese have long depended on its fish for their livelihoods.

Service industries. Government and trade are the most important service activities in Portugal. The federal government heavily controls several industries, including banks, mineral processors, and utilities. Portugal's retail trade establishments benefit from the large numbers of tourists that visit the country. Other service industries include education and health care.

Manufacturing. The production of textiles is the leading manufacturing activity in Portugal. Cotton fabric is the most important type of textile produced in the country. Other leading manufactured goods include food products, paper products, and electrical machinery. Portugal's food-processing activities include meat packing and the production of animal feed, canned sardines, and wine. Portuguese factories also produce cement, ceramics, cork products, shoes, and fertilizer.

Agriculture and fishing. Wine grapes are grown in the river valleys that cut across Portugal. The vineyards of the Douro Valley yield grapes for port wine, which is

E. Grafis, Bruce Coleman Inc.



Flat plains cover much of Portugal. In southwestern Portugal, *left,* the Coastal Plains rise to meet the mountains of the Southern Tablelands.

named for the city of Porto. Grapes from the Madeiras are used for Madeira wine. Other crops grown in Portugal include almonds, corn, olives, potatoes, rice, tomatoes, and wheat. Farmers also raise cattle, chickens, hogs, and sheep. Fishing crews catch cod, sardines, tuna, and many other kinds of fish.

Most crop farms in Portugal are small. The majority of the farmers own the land they work. But some farms, especially in the south, are state-owned collective farms. Large numbers of Portuguese farmers still use old-fashioned methods and equipment, but the use of modern farm methods and equipment is increasing.

Foreign trade. Portugal's major exports include clothing and textiles, cork, paper, and wine. The country imports large amounts of chemicals, grain, iron and steel, petroleum and petroleum products, textile yarn and fiber, and transportation equipment.

From 1960 to 1986, Portugal was a member of the European Free Trade Association (EFTA), an economic organization of nations. In 1986, Portugal left EFTA and joined the European Community (EC), a larger European economic organization of nations. In 1993, Portugal and the other EC countries formed the European Union, which works for both economic and political cooperation among its member nations. At that time, the EC became part of the European Union.

Germany, a member of the European Union, is Portugal's chief trading partner. Portugal also trades heavily with other European Union members, including France, Italy, Spain, the United Kingdom, and with some other European countries. It also trades heavily with the United States.

Transportation. A railroad network connects most of Portugal. The national government owns and operates the main railroad system. The government also owns and operates the national airline, Air Portugal. Lisbon Airport is Portugal's main international airport. Lisbon is the country's chief port.

Portugal has an average of about 1 automobile for every 7 people. In cities, automobiles, buses, and electric streetcars provide much of the transportation. In rural areas, some people still travel by old means, such as oxcart, horse, or mule.

Communication. The national government owns and operates Portugal's telephone, telegraph, and postal systems. Portugal has an average of about 1 radio for every 4 people and about 1 television set for every 5 people. Portugal has about 25 daily newspapers, including *Correio da Manhã* of Lisbon and *Jornal de Notícias* of Porto.

History

Early days. Prehistoric people probably lived in what is now Portugal over 100,000 years ago. The first known inhabitants of the area were called Iberians. These people lived on the Iberian Peninsula—in present-day Portugal and Spain—at least 5,000 years ago.

A number of groups invaded the Iberian Peninsula during early times. Phoenicians from the eastern shore of the Mediterranean Sea established settlements there in the 1000's B.C. Celts, from northern Europe, settled in the area during the 900's B.C., and Greeks arrived in the 600's. Invaders from the powerful North African city of Carthage took control of much of the Iberian Peninsula in the 400's B.C.

Roman rule. In 201 B.C., the mighty Roman Empire defeated Carthage in the Second Punic War (see **Punic Wars**). As part of the peace settlement, Rome gained the right to the Iberian Peninsula. Little by little, the Romans conquered the peoples on the peninsula. They completed their conquest of what is now Portugal by about the time of Christ.

The Romans did much to build up the area that is now Portugal. They established cities and a network of roads there. Latin, the language used by the Romans, became the basis of the Portuguese language. The Roman Empire adopted Christianity as its official religion in the late A.D. 300's. Under Roman rule, Portugal began developing into a Christian land.

The Romans called the Portuguese portion of the Iberian Peninsula *Lusitania.* They named the port and city at present-day Porto *Portus Cale.* These words were the origin of the name *Portugal.*



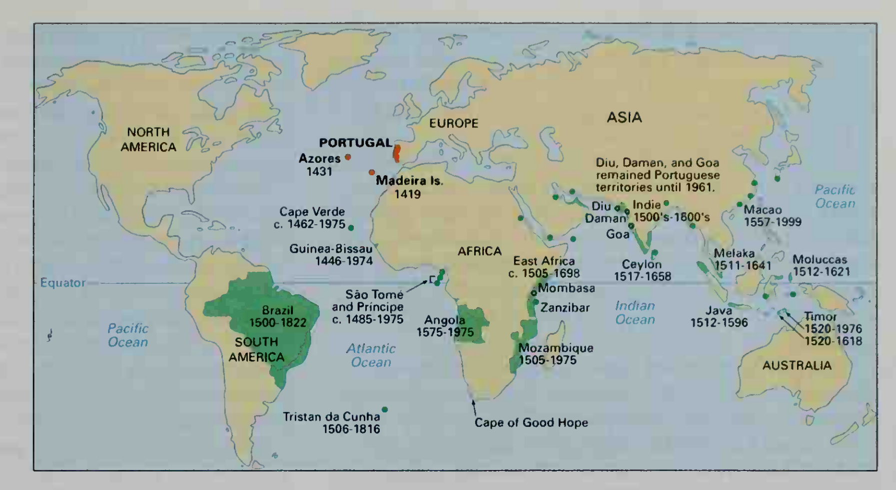
S. C. Bisserot, Bruce Coleman Inc.

Wine made from grapes has long been a leading product of Portugal. A laborer shovels a huge pile of grapes, *above.* The grapes will later be crushed, and wine made from their juice.



Jean Claude Seine, DPI

Producing metals and machinery is one of Portugal's major manufacturing activities. A worker in a Lisbon factory, *above,* cuts a large sheet of metal to a specified size and shape.



Portugal's empire in the mid-1500's, at the height of the nation's power, included colonies in many parts of the world. This map shows these colonial possessions and when Portugal ruled them.

WORLD BOOK map

Visigoths and Muslims. Germanic tribes swept across the West Roman Empire in the A.D. 400's, and helped bring about its collapse in 476. The Visigoths, one of the tribes, conquered the Iberian Peninsula. The Visigoths were Christians, and Portugal remained a Christian land under their rule.

In the early 700's, North African *Muslims* (followers of the Islamic religion) conquered most of what are now Portugal and Spain. They constructed Arab-style buildings, introduced new crops, and improved education and the system of roads.

Many Christians of the Iberian Peninsula opposed Muslim rule. Christian opposition was especially strong in the north. The Christians struggled to retake their land for hundreds of years. In the 1000's, they gained the upper hand. By the mid-1200's, the Christians had driven the Muslims from Portugal and from most of Spain.

Founding the Portuguese nation. Henry of Burgundy, a French nobleman, had joined the Iberian Christians in their fight against the Muslims. In 1094, Alfonso VI, a Christian king of Spain, rewarded Henry with the counties of Porto and Coimbra, in what is now northern Portugal. Alfonso named Henry the Count of Portugal. Portugal was then considered a part of Spain.

Henry of Burgundy's son, Afonso Henriques, won many victories over the Muslims. In 1143, he took the title of king of Portugal, and established Portugal as a kingdom independent from Spain.

In 1385, a new royal line, the House of Aviz, came to the Portuguese throne. King John I became the first Aviz king. His armies defeated Spanish forces and helped guarantee the future independence of Portugal from its powerful neighbor to the east. King John also made an alliance with England. This alliance, still in force, is the oldest existing political alliance in Europe.

The age of exploration. Even before the 1400's, Portuguese traders and fishing crews had sailed far from home into the Atlantic Ocean. By 1400, the Portuguese had gained much knowledge about the sea. They had also mastered navigational skills and the ability to build ships capable of making long voyages.

Henry the Navigator, a son of King John I, was a leading figure in Portugal's rise as a sea power. He never went on a voyage of exploration himself. But his studies contributed much to Portuguese marine skills, and he encouraged and sponsored many explorations.

Portuguese ships reached the Madeira Islands in 1419 and the Azores in 1431. By the time of Henry's death in 1460, the Portuguese had explored the west coast of Africa as far south as what is now Sierra Leone. In 1488, a Portuguese vessel commanded by Bartolomeu Dias sailed all the way around the Cape of Good Hope at the southern tip of Africa. The voyage marked the first time Europeans had rounded the cape.

Manuel I, called Manuel the Fortunate, became king of Portugal in 1495. Determined to increase his country's power and importance, he decided to sponsor a daring voyage around southern Africa to Asia. Vasco da Gama undertook this task in 1497. He led four ships around the Cape of Good Hope, and he reached India in 1498. Manuel soon sent Pedro Álvares Cabral to follow Da Gama's route, but Cabral drifted off course. In 1500, his fleet reached the east coast of what is now Brazil. The Portuguese also reached the coasts of Africa, the Arabian and Malay peninsulas, the East Indies, and Asia.

Empire and wealth. Settlers and soldiers followed closely behind the Portuguese explorers, establishing

Important dates in Portugal

1000's B.C. Phoenicians settled in what is now Portugal.
100's B.C. Portugal became part of the Roman Empire.
A.D. 711 Muslims invaded the Iberian Peninsula.
1143 Portugal became an independent nation.
1419 Portugal began its overseas expansion.
1500 Pedro Álvares Cabral claimed Brazil for Portugal.
1580 Spain invaded and conquered Portugal.
1640 Portugal regained its independence.
1822 Portugal lost its colony of Brazil.
1910 The Portuguese established a republic.
1928 António de Oliveira Salazar, who ruled as a dictator for 40 years, began his rise to power.
1949 Portugal and 11 other nations formed a military alliance, the North Atlantic Treaty Organization (NATO).
1960's Rebellions against Portuguese rule broke out in the country's African colonies.
1974 A revolution overthrew the Portuguese dictatorship.
1975 Almost all remaining Portuguese colonies gained independence.
1976 Portugal held its first free general elections in more than 50 years.
1986 Portugal joined the European Community, an organization that later became the basis of the European Union.

colonies. By the mid-1500's, Portugal controlled a vast overseas empire that included colonies in what are now the African countries of Angola, Cape Verde, Guinea-Bissau, Mozambique, and São Tomé and Príncipe; and in Brazil, Malaysia, Indonesia, and China.

Portugal gained great wealth from the resources of its colonies. It profited from the spice trade in Asia. It got gold from Africa and also took part in the slave trade there. Brazil yielded such valuable items as diamonds and gold. The empire also gave Portugal vast amounts of new land. Portuguese planters in Brazil, Africa, and elsewhere raised crops that contributed to the country's economy.

Years of decline. Portugal held on to much of its empire well into the 1900's. However, the country declined as an economic and world power much earlier.

As far back as the late 1500's, there were signs that Portugal had overextended itself. The small nation found that it had too few ships, settlers, soldiers, and sailors to manage and defend its vast empire well. In the 1600's, rival European states, including England, the Netherlands, and France, began to take over parts of the empire.

Internal policies and the effects of the Inquisition also contributed to Portugal's decline. Its kings had gained enormous power, and they ruled the people with strict measures. The Inquisition was an effort by the Roman Catholic Church to end *heresy* (opposition to its teachings). It further hurt the country's cultural and economic development. Many Portuguese Christians and Jews were killed or imprisoned during the Inquisition, and thousands of Jews were expelled from the country.

Spanish conquest. Spain invaded and conquered Portugal in 1580 and ruled the country for 60 years. In 1640, John, Duke of Braganza, led a rebellion that drove out the Spaniards and restored Portugal's independence. John became the first king of the House of Braganza, the last Portuguese line of monarchs. He took the title of John IV.

A brief revival. Portugal entered a period of economic revival about 1660. Revenue from Brazil's gold, diamonds, and farm products contributed greatly to the upsurge. A trade agreement made with England in 1703 also aided Portugal. Called the Methuen Treaty, it ensured steady trade between the two countries that benefited both.

England, which joined Scotland and Wales to form the United Kingdom in 1707, also helped Portugal maintain its status as an independent nation. Spain sought to regain control of Portugal, but England—an enemy of Spain—pledged aid to Portugal against foreign invaders. Between 1703 and the mid-1800's, the British acted several times to defend Portugal from invasion or threats by Spain or Spain's allies.

In 1807, French forces under Napoleon I invaded and conquered Portugal. But the British raised an army under Arthur Wellesley, later the Duke of Wellington, that finally drove the French forces from Portugal in 1811. The brief period of French rule marked the last time Portugal was controlled by outsiders.

A weakening monarchy. King John VI of Portugal fled to Brazil during the French occupation. He returned to Portugal in 1821. By that time, a spirit of political reform had grown strong in Europe. Many Portuguese demanded a more representative government and a limit to the power of the king. Portuguese army officers had revolted in 1820. In 1821, John VI agreed to a constitution that provided for some representative government.

In 1822, the Portuguese empire suffered a major blow. Brazil, the wealthiest part of the empire, declared its independence. See Brazil (History).

The first Portuguese republic. For many years, Portugal made little actual progress toward true representative government. The monarchy remained strong and the people had little voice in government. Opposition to the government grew steadily. In 1908, King Carlos I and his eldest son were assassinated in Lisbon by revolutionaries who wanted to end the monarchy's power. The king's young son, Manuel II, then came to the throne, but revolutionaries overthrew him in 1910 and established Portugal as a republic.

Portugal's first attempt at parliamentary democracy was a failure. It was marked by excessive government interference in society and political instability. In 15 years, the country had 45 different governments. The republic's leaders faced labor unrest and revolts by the military and civilians. Portugal fought on the side of the Allies during World War I (1914-1918), and the war costs weakened its already shaky economy.

The Salazar dictatorship. In 1926, army officers overthrew Portugal's civilian government. They abolished parliament, suspended civil rights, and set up a dictatorship. The officers were unable to solve the country's economic problems. In 1928, they chose António de Oliveira Salazar, an economics expert, to serve as minister of finance. But Salazar's role soon extended far beyond financial matters. Salazar soon took control of the government and began to rule as a dictator. He was named prime minister in 1932.

Salazar's government was a *right-wing* (conservative) dictatorship. It allowed the people few rights, and it included a secret police organization that crushed all opposition. Salazar's economic policies favored the wealthy, and poverty spread during his dictatorship.

In the mid-1900's, most European nations began granting independence to colonies they still held. But Salazar refused to give up Portugal's remaining colonies in spite of demands from the colonies and the United Nations. Salazar stressed the unity of Portugal and its colonies, which, after 1951, were called overseas provinces.

In 1961, Indian troops forced Portugal to give up its last colonial holdings in India. At about the same time, rebels in Portugal's black African colonies of Angola, Mozambique, and Portuguese Guinea (now Guinea-Bissau) began armed struggles against their Portuguese rulers. Portugal sent troops to fight the rebels. Thousands of people on both sides were killed, and the cost of the fighting further weakened Portugal's economy.

Salazar suffered a stroke in 1968, ending his long public career. He died two years later. Marcello Caetano replaced him as Portugal's ruler in 1968. Caetano took steps to reduce the harsh rule of the dictatorship, but not enough to suit many Portuguese.

The 1974 revolution. Military officers overthrew the dictatorship in 1974. They called their revolution the *Armed Forces Movement.* The movement abolished the secret police, restored rights to the people, and established a provisional government to run the country.

As part of the reforms, political parties were permit-

ted in Portugal for the first time since the 1930's. Communists, Socialists, and parties that favored free enterprise sought to control the new government. In 1974 and 1975, violence broke out between Portuguese people of differing political views.

End of the empire. Portugal's new government promised to end the country's control of its colonies. The African land of Portuguese Guinea gained independence as Guinea-Bissau in 1974. Angola, Cape Verde, Mozambique, and São Tomé and Príncipe—also in Africa—all gained independence from Portugal in 1975. In 1976, Portugal's colony of Portuguese Timor in the East Indies was taken over by Indonesia.

Shortly after these changes, Portugal began the process of returning the territory of Macao to China. Macao officially returned to China in 1999. Portugal now rules only its mainland territory and the Azores and Madeira Islands.

Political changes. In April 1975, Portugal held elections for the Constituent Assembly, a group chosen to write a constitution for the country. In April 1976, the new constitution took effect and established Portugal as a parliamentary democracy. Later that same month, the voters elected a president and members of the Assembly of the Republic, the country's new parliament. The Portuguese military kept an advisory role until 1982.

Between 1976 and 1985, control of Portugal's government changed hands a number of times. In 1985, the conservative Social Democratic Party gained control of the government. It held power for the next 10 years and brought a degree of political stability to the country.

Portugal experienced economic growth in the last half of the 1900's, but it also faced economic problems. Its costly wars in Africa and the internal violence that followed the 1974 revolution helped bring the economy to a state of near-collapse temporarily. After the revolution, there were periodic problems of inflation and high unemployment. But Portugal shared in the general European prosperity of the 1990's.

Recent developments. In 1995, Portugal's liberal Socialist Party gained the largest number of seats in the Assembly, and the head of the party became prime minister. The Socialist candidate for president, Jorge Sampaio, was elected in 1996 and reelected in 2001. In elections in 2002, the Social Democrats, a more conservative party, won the most seats in the Assembly.

Douglas L. Wheeler

Related articles in *World Book* include:

Biographies

Cabral, Pedro Á.
Da Gama, Vasco
Dias, Bartolomeu
Henry the Navigator
John VI
Magellan, Ferdinand
Pedro I
Salazar, António

Cities and towns

Braga
Funchal
Lisbon
Porto

History

Africa (The beginnings of European control)
Angola
Brazil
Cape Verde
East Timor
Guinea-Bissau
Iberia
Kongo
Latin America (History)
Line of Demarcation
Macao
Mozambique
São Tomé and Príncipe
World War I

Physical features and districts

Azores
Madeira Islands
Tagus River

Other related articles

Fátima, Our Lady of
Portuguese language

Outline

I. Government
- A. National government
- B. Local government
- C. Politics
- D. Courts
- E. Armed forces

II. People
- A. Population and ancestry
- B. Way of life
- C. Language
- D. Religion
- E. Education
- F. The arts

III. Land and climate
- A. Land regions
- B. Rivers
- C. Climate

IV. Economy
- A. Natural resources
- B. Service industries
- C. Manufacturing
- D. Agriculture and fishing
- E. Foreign trade
- F. Transportation
- G. Communication

V. History

Questions

What is the origin of the name *Portugal?*
What were the roles of Afonso Henriques, Henry the Navigator, and Manuel I in Portuguese history?
What were some features of Portuguese golden age art?
What are Portugal's chief crops?
How did explorations bring wealth to Portugal?
Why is the town of Fátima important?
How does the Tagus River serve as a dividing line?
Which country is Portugal's oldest ally?
What are Portugal's main land regions?
What problems does Portugal face today?

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Portuguese East Africa. See Mozambique.

Portuguese Guinea. See Guinea-Bissau.

Portuguese language is the official language of Portugal, Brazil, Mozambique, and Angola. The language is also spoken by about 300,000 people in the United States. About 2 million people in northwestern Spain speak a Portuguese dialect called *Galego* or *Galician.* There are four principal dialects of Portuguese spoken today. The *Northern, Central,* and *Southern* dialects are used in Portugal, and the *Brasileiro* dialect is spoken in Brazil. Portuguese is a Romance language similar to Spanish (see **Romance languages**).

Portuguese and Spanish were essentially the same language until about A.D. 1143, when Portugal broke away from Spanish control. As Portuguese evolved, it developed distinctive phonetic and grammatical characteristics. Portuguese colonizers carried the language to Brazil during the 1500's. The Brazilians added words from the Tupi Indians and from African slaves. Brazilian Portuguese came to have the same relation to the language that American English has to British English.

Since the early 1900's, many persons in Portugal and Brazil have wanted to simplify and standardize Portuguese spelling. Scholars wished to take out many double consonants and other old-fashioned letter combinations. In 1943, the governments of Portugal and Brazil approved a new system, in which *f* is substituted for *ph*, *t* for *th*, and *i* for *y*. Richard P. Kinkade

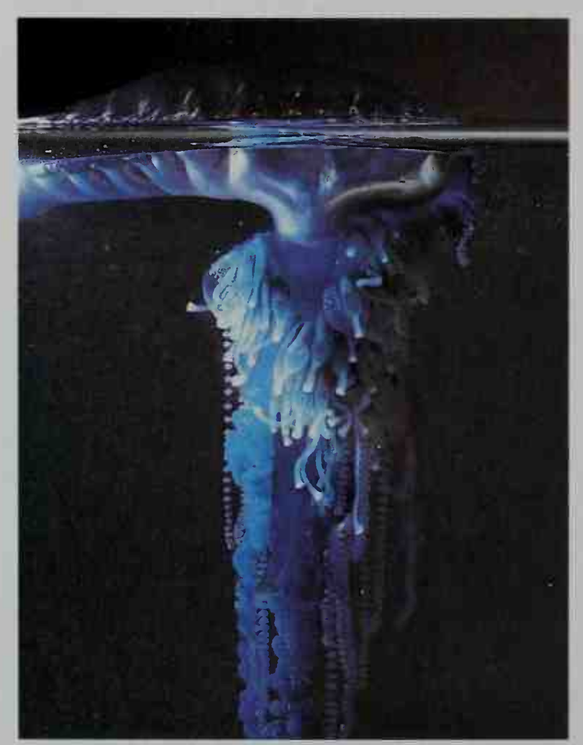
See also **Spanish language** (Development).

Portuguese man-of-war is a floating creature found in warm oceans throughout the world. Although it resembles a jellyfish, it actually consists of a colony of hundreds of members.

The colony begins with just one *larval member*. As it grows, this original member produces new organisms of several different types, by a process called *budding* (see **Reproduction** [Through asexual reproduction]). The original member develops into a blue, balloonlike *float* that is filled with gas. This structure keeps the colony afloat. It also acts as a sail, catching the wind and moving the colony about.

The other members of the colony hang from the float. Stringlike members called *tentacles* catch food. When touched, the tentacles discharge poison that paralyzes and kills fish. The tentacles then haul the prey up to tube-shaped members that digest food for the entire colony. Other members produce the eggs and sperm necessary for reproducing new colonies.

A large Portuguese man-of-war may have a float 10 inches (25 centimeters) long and tentacles 30 feet (9 meters) long. The Portuguese man-of-war was probably named by sailors, who thought the animal's float resembled a type of sailing ship that was called a *man-of-war*.



Maira & Rod Borland, Bruce Coleman Inc.

The Portuguese man-of-war floats on the surface of warm oceans. It catches food with its submerged poisonous tentacles.

The Portuguese man-of-war often stings swimmers. Although it is rarely fatal, the sting causes a severe skin rash, extreme pain, nausea, and breathing difficulties. A Portuguese man-of-war washed up on the beach remains dangerous and should not be touched.

Scientific classification. The Portuguese man-of-war belongs to the phylum Cnidaria. Its scientific name is *Physalia physalis*. G. O. Mackie

Portuguese water dog is a breed of dog noted for its exceptional swimming ability. Portuguese water dogs can swim as far as 5 miles (8 kilometers) and dive to depths of 12 feet (3.7 meters). For hundreds of years, the Portuguese have used these dogs in fishing to pull fish and nets from the ocean. The dogs have also served as messengers between ships.



Portuguese Water Dog Club of America, Inc.

The Portuguese water dog is a strong swimmer. For hundreds of years, it has served as a working companion to Portuguese fishing crews, who have used it to pull in fish and nets.

The origins of the Portuguese water dog are uncertain. According to one theory, Portuguese water dogs descended from sheepdogs in southern Russia. Migrating tribes brought the sheepdogs to northwestern Africa by the 700's. From there, Moor invaders carried the dogs to Portugal, where they were bred to become water dogs.

Portuguese water dogs are muscular and have webbed feet and a tail that curls over the back. The webbed feet enable the dogs to tread water, and the tail serves as a rudder while swimming. Males stand 20 to 23 inches (51 to 59 centimeters) tall at the shoulder and weigh 42 to 60 pounds (19 to 27 kilograms). Females are slightly smaller. The dog's coat may be long and wavy or short and curly. The most common colors are black and white, and brown and white. Joan McDonald Brearley

Portuguese West Africa. See **Angola** (History).

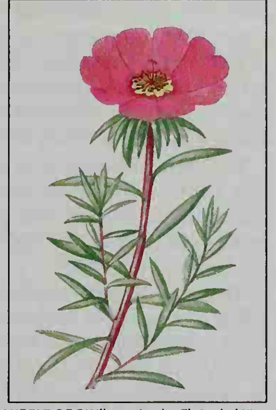
Portulaca, *PAWR chuh LAK uh,* is the name of a group of herbs with dainty red, yellow, pink, white, or purple flowers. The *rose moss* of Brazil, grown as a garden flower, grows flat or as tall as 1 foot (30 centimeters). It has narrow, fleshy leaves about 1 inch (2.5 centimeters) long. The *kitchen-garden portulaca* grows to $1\frac{1}{2}$ feet (46 centimeters) tall, with bright yellow flowers about $\frac{1}{2}$ inch (13 millimeters) wide, and broad leaves.

Portulacas make beautiful plants for a border or a

rock garden. They grow best in a sunny location in poor, rather light soil. The flowers open only in full sun. Several species make charming potted plants. But they are not satisfactory as cut flowers.

Robert A. Kennedy

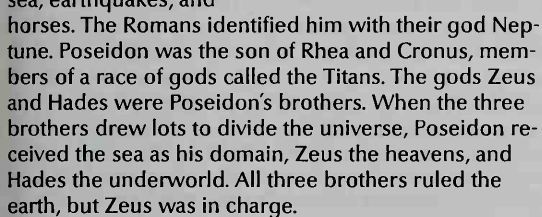
Scientific classification. Portulacas belong to the purslane family, Portulacaceae. The scientific name for rose moss is *Portulaca grandiflora.* The kitchen-garden portulaca is *P. oleracea.*



WORLD BOOK illustration by Christabel King

Portulaca

Poseidon, *puh SY duhn,* was the Greek god of the sea, earthquakes, and horses. The Romans identified him with their god Neptune. Poseidon was the son of Rhea and Cronus, members of a race of gods called the Titans. The gods Zeus and Hades were Poseidon's brothers. When the three brothers drew lots to divide the universe, Poseidon received the sea as his domain, Zeus the heavens, and Hades the underworld. All three brothers ruled the earth, but Zeus was in charge.



Poseidon's wife was the sea goddess Amphitrite. They had two daughters and a son, the sea god Triton. Poseidon's offspring from countless love affairs included the magical horses Pegasus and Arion and the giants Antaeus and the one-eyed Polyphemus. In the epic poem the *Odyssey,* Poseidon hated the Greek hero Odysseus (Ulysses in Latin) for blinding Polyphemus. In some myths, Poseidon was also the father of the mortal hero Theseus.

Poseidon's attendants were the sea gods Phorcys, Proteus, and Nereus, and sea nymphs called *Nereids.* Like other sea deities, Poseidon often changed his shape. He drove a horse-drawn chariot and carried a three-pronged spear called a *trident.* Nancy Felson

See also **Andromeda; Athena; Neptune; Pegasus.**

Positive number. See **Algebra** (Positive and negative numbers).

Positivism is a variation of the philosophical theory called *empiricism.* This theory states that all knowledge is based on experience. There are two forms of positivism. Auguste Comte, a French philosopher, developed the first form of positivism in the 1800's. The second form, known as *logical positivism,* originated during the 1920's in a group of philosophers called the Vienna Circle.

Comte's positivism is based on his three-stage evolutionary account of history. According to Comte, human thought goes through three stages: (1) theological, (2) metaphysical, and (3) positive or scientific. In the theological stage, people explain existence in terms of the actions of divine beings. In the metaphysical stage, explanations are sought in terms of basic causes and principles. In the positive stage, people use the *positive method* to explain existence. This method consists of reasoning by reference to observation alone.

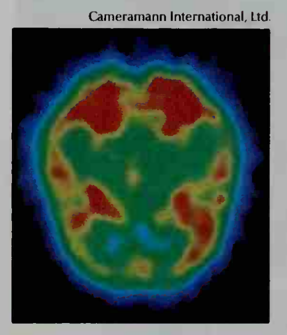
Comte urged that the positive method be used for all scientific study, including the study of humanity. He argued that humanity should be studied through biology and *sociology,* a term he originated. Comte taught that progress should aim for *sociocracy,* a social state based on science and a new *religion of humanity.* Philosophers would govern this state according to the principles of positivism. See **Comte, Auguste.**

Logical positivism was developed by the Vienna Circle under the leadership of the German physicist and philosopher Moritz Schlick. The group included the German philosopher Rudolf Carnap and several other leading philosophers and scientists. Its main doctrine was a controversial idea called the *verifiability criterion of meaning.* According to this doctrine, all statements that cannot be verified by sense perception—except for provable statements of mathematics or logic—are meaningless nonsense. The Vienna Circle aimed to eliminate such unverifiable statements and ideas from science and philosophy. W. W. Bartley III

Positron emission tomography (PET), *tuh MAHG ruh fee,* is a technique used to produce images of the chemical activity of the brain and other body tissues. PET enables scientists to observe chemical changes in specific regions of a person's brain while the person performs various tasks, such as listening, thinking, or moving an arm or leg. Scientists use PET to com-



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Cameramann International, Ltd.

A PET scan produces images of the brain's chemical activity. The patient's head is placed inside a ring of sensors, which pick up gamma ray signals from the brain. A computer processes these signals to form a cross-sectional color image, *left.* The colors show the rate of activity in specific brain regions. Red indicates a high rate of activity.

pare the brain processes of healthy people and people with diseases of the brain. Research is being done to see if it is possible to use these comparisons to identify abnormalities that underlie various brain disorders. These disorders include such mental illnesses as bipolar disorder and schizophrenia, as well as such conditions as Alzheimer's disease, cerebral palsy, epilepsy, and stroke. PET also helps doctors diagnose certain other disorders, including heart disease and cancer.

In a PET scan of the brain, the patient's head is positioned inside a ring of cameralike sensors. These sensors can detect *gamma rays* (short-wave electromagnetic radiation) from many angles. A solution containing glucose bound to a harmless amount of a radioactive substance is injected into a vein. This radioactive *labeled glucose* mixes with the glucose in blood and soon enters the brain.

The radioactive substance gives off *positrons,* particles identical to electrons but carrying an opposite electric charge. The positrons collide with electrons present in brain tissue and gamma rays are *emitted* (given off). The sensors record the points where these rays emerge. A computer then assembles these points into a three-dimensional representation of the emitting regions. This representation is displayed on a video screen as cross-sectional "slices" through the brain.

Colors in a PET image show the rate at which specific brain structures consume the glucose. The rate of glucose consumption indicates how active these structures are during a particular task. For example, if the person having the PET scan looks at an object, the brain region that receives and interprets visual signals will appear red on the screen. Red indicates the highest rate of activity. Other colors that appear in PET images include orange—the next highest rate of activity—yellow, green, and blue, the lowest rate. Michael E. Phelps

Possession. See Exorcism.

Possessive case. See Case.

Possum is a type of furry mammal that lives in the trees of Australia, New Guinea, and nearby islands. Possums are *marsupials*—that is, the females give birth to young that complete their development while attached to the mother's nipples. Like most marsupials, young possums develop while carried about in a pouch on their mother's abdomen. Both possums and opossums are marsupials, but they are not closely related.

Possums move about at night and sleep during the day. They have handlike hind feet that help them grasp the branches of trees. Possums eat mainly blossoms, fruits, insects, and sap. The animals have black, brown, gray, tan, or white fur.

There are about 40 species of possums. The *brush-tailed possum* lives in Australian cities and raids fruit trees and garbage cans for food. Brush-tailed possums weigh from 3 to 11 pounds (1.4 to 5 kilograms). Other large species of possums, called *cuscuses,* weigh as much as 8 pounds (3.4 kilograms). The mouse-sized *honey possum* has a long, tube-shaped mouth and feeds on nectar and pollen. *Pygmy possums* weigh as little as $\frac{1}{2}$ ounce (14 grams). Several species of possums, called *gliders,* have large folds of skin between the front and rear legs on each side of the body. When the legs are spread, this skin serves as wings for gliding.

Scientific classification. The brush-tailed possum and cuscuses belong to the family Phalangeridae. The honey possum makes up the family Tarsipedidae. Pygmy possums belong to the family Burramyidae. Most gliders are in the family Petauridae. Michael L. Augee

© Stanley Breeden, DRK

A possum feeds on the yellow blossoms of a tree, *above.* Possums sleep during the day and are active at night.

Post, Emily Price (1873?-1960), made a career out of good manners. Her book *Etiquette* tells people how to behave properly in all types of social situations. After its publication in 1922, Post became established as an authority on proper behavior. She emphasized that good manners are based on common sense and a regard for the feelings of others. She revised her book frequently to take into account changing social conditions and new patterns of social behavior.

Post was born in Baltimore, Md., the daughter of a wealthy architect. Her first book, *The Flight of the Moth* (1904), was a fictional story of life among socially gracious people in the early 1900's. Her other books include *How to Behave Though a Debutante* (1928), *The Personality of a House* (1930), *Children Are People* (1940), and *Motor Manners* (1950). She also wrote newspaper columns and made radio broadcasts. Letitia Baldrige

Post, Wiley (1899-1935), a pioneer American aviator, was the first person to make a solo flight around the world. He made the historic flight in 1933 in a single-engine Lockheed Vega nicknamed *Winnie Mae,* covering 15,596 miles (25,099 kilometers) in 7 days 18 hours 49 minutes. Post used a new automatic pilot system that steered the plane while he rested. Two years earlier, Post and navigator Harold Gatty had flown the *Winnie Mae* around the world in a record 8 days 15 hours 51 minutes.



United Press Int.

Wiley Post

Post was born in Van Zandt County, Texas. He learned to fly in the 1920's and bought his first plane

in 1926. Post flew in a number of speed events, winning the National Air Race of 1930.

Post later advanced high-altitude flight by helping design a rubber suit that allowed him to operate in low air pressures at more than 30,000 feet (9,000 meters). Post died in a plane crash in Alaska with his friend the cowboy-humorist Will Rogers. Roger E. Bilstein

Post exchange is a store or shop that the United States Department of Defense operates for active-duty and retired military personnel, and their families. The Army and Marine Corps usually call it a *PX.* The other services usually refer to it as a *base exchange.* On board vessels, the exchange is called a *ship's store.* Major post exchanges resemble department stores. They sell a wide range of goods, from such personal items as toilet articles to automobile parts and home appliances. Many have beauty and barber shops. Joel Slackman

Post mortem. See Autopsy.

Post office. See Postal Service, United States; Postal services.

Post Office Department. See Postal Service, United States.

Postage stamp. See Postal Service, United States (Post office services); Stamp; Stamp collecting.

Postal Service, United States, is an independent establishment within the executive branch of the United States government. It provides mail services, including pickup and delivery, and sells postage stamps and postal money orders. The Postal Service is one of the world's largest organizations, with tens of thousands of post offices and hundreds of thousands of employees. The Postal Service began operating in 1971, when it replaced the United States Post Office Department. The Postal Service has headquarters in Washington, D.C.

The central tasks of all postal administrations are the collection, sorting, and delivery of mail. For descriptions of these processes, see Postal services (How mail is delivered). This article focuses on the procedures, services, and history specific to the United States Postal Service.

Classes of mail

The Postal Service divides all domestic mail into five classes. These classes are (1) Express Mail® service, (2) First-Class Mail® service, (3) periodicals, (4) standard mail, and (5) package services. Each class of mail has its own rate structure. The Postal Service sorts mail using *ZIP Codes.* ZIP Codes are sets of numbers that signify particular *zones,* or geographical areas. The name stands for *Z*one *I*mprovement *P*lan.

Express Mail service travels faster than any other class of mail. This service guarantees next-day delivery to specified locations throughout the country. If the mail does not reach its destination by the next day, the Postal Service refunds the cost of the postage to the sender.

First-Class Mail service includes letters, postal cards, and other material that is at least partly written. First-Class Mail service costs more and travels faster than any other class of mail except Express Mail service. Priority Mail® service is First-Class Mail service for items weighing more than 13 ounces (0.37 kilogram). Mailers also have the option to send items weighing less than that amount by Priority Mail. In most cases, the mail is delivered in two days.

Periodicals is a class of mail consisting of magazines, newspapers, and other publications formed of printed sheets. These are items that are issued at least four times a year at regular, specified intervals from a known office of publication. Periodicals usually must have a list of subscribers or a list of requests.

Standard mail consists of all mail items weighing less than 1 pound (0.45 kilogram) that are not included in First-Class Mail service. Such mail includes newspapers, magazines, newsletters, and bulletins that do not meet the requirements for the periodicals class, as well as advertising circulars, catalogs, and lightweight merchandise samples.

Package services involve the shipment of all mail weighing 1 pound (0.45 kilogram) or more that is not considered First-Class Mail or periodicals. The Postal Service also offers special rates to people who send books, other bound printed matter, and library materials by mail. Package mail that does not qualify for such special rates is called Parcel Post® service.

Post office services

In addition to providing the different classes of mail service, the Postal Service has many other functions. It sells materials and supplies, and it offers a variety of specific mail options.

Stamps and other mailing materials. Stamps are placed on packages and letters as proof that the sender has paid for mailing the item. At times, the Postal Service issues special *commemorative stamps.* Some commemoratives honor distinguished people who have died. Others pay tribute to historic events, places of scenic beauty, or outstanding organizations.

Post offices also sell *stamped envelopes, postal cards,* and *air letters.* Stamped envelopes and postal cards come with postage already printed on them. Postal cards differ from post cards, which are made by private companies and carry no postage. Air letters are light-



United States Postal Service

The delivery of mail is one of the main services provided by the United States Postal Service. Many letter carriers drive special Postal Service vehicles along their routes.

weight sheets of paper that can be folded to form envelopes.

Special handling is a service that enables customers to send standard mail and packages faster than normal. Mailers must pay an extra fee for this service, which provides preferential treatment in sending and transportation, but not in delivery.

Extra protection. Some services provide special protection for the items postal customers send through the mail. Customers must pay an extra fee for these services, which include *insurance, registered mail,* and *certified mail.* Insurance pays, up to a certain amount, the value of items lost or damaged in the mail. Registered mail provides protection for irreplaceable items or for particularly valuable items. Certified mail is a special service that provides the sender with a receipt at the time of mailing. Return receipts, issued at the time of delivery, are available for additional fees.

Electronic services. The Postal Service has introduced several programs to take advantage of computer and Internet technology. *NetPost Mailing Online* enables people to create a message on a computer and send it electronically to the Postal Service. The Postal Service, in turn, prints the message and delivers it to its destination. An electronic bill-paying system called *USPS eBillPay* allows users to receive and pay bills online. The *Post Electronic Courier Service* allows users to send electronic documents securely through the Postal Service.

Other services. Post offices sell *postal money orders,* which enable customers to transmit money for a fee. The Postal Service refunds the value of postal money orders that are lost or stolen in the mail. In addition, the Postal Service rents *post office boxes,* which stand in post office lobbies and at various off-site locations. All mail addressed to a box number stays in the box until the boxholder collects it.

Other services offered by post offices include *COD service* and *metered postage.* COD, which stands for *collect on delivery* or *cash on delivery,* enables a person to order merchandise by mail and pay for it when it arrives. *Postage meters* are devices that companies use in their offices to print the postage and postmark directly on envelopes. Companies lease the meters from an authorized manufacturer, then obtain a permit from the Postal Service to use them.

The Postal Service also publishes postal manuals and the *National Five-Digit ZIP Code and Post Office Directory.*

Organization

An 11-member Board of Governors directs the Postal Service. Nine of the members are appointed by the president, with the advice and consent of the Senate. These members appoint the postmaster general, who becomes the 10th member of the board and serves as the chief executive officer of the Postal Service. These 10 members, in turn, appoint the deputy postmaster general, who becomes the 11th board member and the postmaster general's chief assistant. The postmaster general and the deputy are responsible for day-to-day operations.

The executive branch of the U.S. government also has an independent five-member Postal Rate Commission. The members are appointed by the president with the advice and consent of the Senate. They recommend postal rates and classifications for adoption by the Board of Governors.

History of postal services in the United States

Colonial times. The first known official postal system in the American Colonies appeared in 1639 in Boston. In most places, taverns or inns served as post offices. In 1691, King William III of England gave Thomas Neale, a colonial official, the right to provide mailing services in the colonies. Neale's deputy, Andrew Hamilton, created the colonies' first national postal system. In 1707, the British government took control of the system. Shortly afterward, it greatly increased postal rates.

Benjamin Franklin became a deputy postmaster general for the American Colonies in 1753. He improved the frequency and reliability of mail delivery. However, rates remained high. The American colonists fiercely opposed the high rates, which they considered an unfair tax. As a result, many of the colonists avoided using the royal postal system and sent letters by private, illegal carriers.

After the Revolutionary War in America (1775-1783) began, the Second Continental Congress named Franklin the first postmaster general of the United States. The nation won its war for independence in 1783. In 1789, Congress gave the federal government the sole power to provide mailing services. Samuel Osgood became the first postmaster general to serve under the new Constitution.

During the 1800's and early 1900's, mailing services grew rapidly in the United States. Congress issued the

Postal Service abbreviations for states and other areas

State or area	Abbreviation	State or area	Abbreviation	State or area	Abbreviation	State or area	Abbreviation
Alabama	AL	Illinois	IL	Nebraska	NE	South Carolina	SC
Alaska	AK	Indiana	IN	Nevada	NV	South Dakota	SD
Arizona	AZ	Iowa	IA	New Hampshire	NH	Tennessee	TN
Arkansas	AR	Kansas	KS	New Jersey	NJ	Texas	TX
California	CA	Kentucky	KY	New Mexico	NM	Utah	UT
Colorado	CO	Louisiana	LA	New York	NY	Vermont	VT
Connecticut	CT	Maine	ME	North Carolina	NC	Virgin Islands	VI
Delaware	DE	Maryland	MD	North Dakota	ND	Virginia	VA
District of Columbia	DC	Massachusetts	MA	Ohio	OH	Washington	WA
Florida	FL	Michigan	MI	Oklahoma	OK	West Virginia	WV
Georgia	GA	Minnesota	MN	Oregon	OR	Wisconsin	WI
Guam	GU	Mississippi	MS	Pennsylvania	PA	Wyoming	WY
Hawaii	HI	Missouri	MO	Puerto Rico	PR		
Idaho	ID	Montana	MT	Rhode Island	RI		

Early days with the United States mail



Series of 1847—Portrait of Franklin

Benjamin Franklin became the first American postmaster general in 1775.

Photos courtesy of the U.S. Postal Service

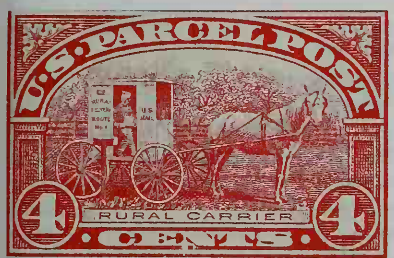


Parcel Post Stamp—Issue of 1912-1913

The first railway mail cars began operating in 1864. The first official test run of this service was made on August 28, between Chicago and Clinton, Iowa.



Overland mail traveled by stagecoach from Missouri to California. It followed a southern route via Texas. The trip took 25 days.



Parcel Post Stamp—Issue of 1912-1913

Rural free delivery started in 1896. In the first week, patrons received 214 letters, 33 postal cards, and 2 packages, and sent 18 letters and 2 packages.



Pony Express Commemorative Stamp—Issue of 1940

Pony express riders carried U.S. mail between St. Joseph, Missouri, and Sacramento, California. They generally rode almost 2,000 miles (3,200 kilometers) in about 10 days.



Airmail Stamp—Issue of 1918

The first regular airmail service in the world was inaugurated in 1918. The flight was between Washington, D.C., and New York City.

first postage stamps in 1847 and began to require the prepayment of postage in 1855.

The pony express was one of the most colorful episodes in American postal history. In 1860 and 1861, daring horseback riders carried mail from St. Joseph, Missouri, to Sacramento, California, in about 10 days. In 1861, the transcontinental telegraph eliminated the need for the pony express.

In 1863, the U.S. Post Office Department established three classes of mail and began to provide free delivery in many cities. Other services that were introduced in the middle and late 1800's included postal money orders, special delivery, and postal cards. In 1913, the Post Office introduced parcel post service, insured mail, and COD service. In 1943, the department divided major cities into numbered postal zones.

Technological advancements. The development of modern means of transportation improved the speed and reliability of mail delivery. In 1864, the Post Office officially established the railway post office. In 1911, an American pilot named Earle Ovington made the first official airmail flight in the United States. In 1918, airplanes began to carry mail regularly. Since 1975, nearly all First-Class Mail service going more than 200 miles (320 kilometers) has traveled by air.

In the 1960's, the department began to use high-speed equipment to perform many of the tasks previously done by hand. The 1963 introduction of ZIP Codes allowed the Post Office to sort large volumes of mail mechanically. Additional advancements further modernized the postal system's operations and increased the speed of mail processing.

Establishment of the Postal Service. Until 1970, the Post Office followed a policy of providing low-cost mail service to customers regardless of what it cost the department. As a result, the department's expenses usually exceeded its earnings. Each year, Congress gave the Post Office money to make up for the losses.

On Aug. 12, 1970, President Richard M. Nixon signed a bill to replace the Post Office Department with the new United States Postal Service. The bill also removed the postmaster general from the Cabinet. The Postal Service began operating on July 1, 1971. Since 1983, the agency has become essentially self-supporting.

Since the 1970's, the Postal Service has developed a variety of programs to automate mail processing and to provide more efficient service. These developments have included new delivery standards and mail categories, discounts for presorted mail, expanded ZIP Codes with additional digits, the increased use of bar codes for electronic sorting, and additional electronic mail options.

Critically reviewed by the United States Postal Service

See also **Postal services** and its list of *Related articles.*



© Steve Warmowski, *Journal-Courier*/The Image Works

At a post office, customers buy stamps, envelopes, and other postal supplies, send money orders, and register packages to be mailed. Other postal services include the renting of post office boxes and the collection, sorting, and delivery of mail.

Postal services

Postal services, also called mail services, are the procedures involved in the collection, handling, and delivery of letters, messages, and packages. *Post offices* are places where mail is handled and postal materials and services are sold. The terms *postal service* and *post office* can also refer to a government agency that provides mail services. In the United States, the government agency that provides mail services is called the United States Postal Service. In the United Kingdom, it is called the Post Office. India Post provides similar services in India, as does An Post in Ireland. In Australia, the postal service is the Australian Postal Corporation, which operates under the name Australia Post; in Canada, it is the Canada Post Corporation, or Canada Post.

Mail is perhaps the one service of central government that touches nearly every citizen on almost a daily basis. Indeed, in many small towns, the post office is the only government building. By means of letters, people can share news and make plans with friends and relatives far away. Businesses send bills and receive payments through the mail. Most magazines and mail-order catalogs are delivered by mail.

Postal services have played a major role in the building of nations and the uniting of people throughout history. In ancient times, an extensive system of messenger routes served to knit the Roman Empire together. In Australia, Canada, and the United States, the postal services helped promote democracy by uniting citizens who were scattered over a vast continent. Until well into the 1900's, the postal services were the primary vehicle for communication and marketing.

The postal industry is big business. Postal agencies are large organizations, traditionally government-run, with many complicated managerial and economic concerns. The United States Postal Service, for example, is the country's largest single employer of civilian labor, with about 900,000 full- and part-time employees. About 80 percent of the costs of postal administrations go for payrolls and other labor expenses.

Mail service has long ranked as a vital public service, as well as a source of revenue for the government. Postal systems traditionally have an obligation of *universal postal service*—that is, a duty to deliver to every address in the country and to charge the same rate regardless of location and distance. Maintaining universal postal service would be difficult or impossible without government intervention. For this reason, most governments have provided national post offices with a legal *monopoly,* the right to be the only provider of certain types of mail service.

Although the post is an old and important institution, mail services worldwide have gone through great change. New electronic means of communication challenge the traditional role of mail for personal and business communication. In addition, the rise of private courier firms that provide shipping and delivery services has brought increased competition to the postal industry. The question of how to react to competition from new technologies and from private firms, while still upholding its universal service obligation, is a vital one for mail service today.

How mail is delivered

The sending of a letter or package is a long, complicated process. Many people and machines handle the mail before it reaches its destination. This section describes what happens to mail as it travels from the sender to the receiver.

Collection. A person can mail a letter by taking it to a post office, by dropping it into a mailbox, or by handing it to a postal worker. Senders place *postage stamps* on letters as proof that they have paid the mailing charges in advance. Many towns and cities maintain mailboxes, also called *collection boxes,* along many streets. Many large office towers and apartment buildings also have

mailboxes. Postal employees called *letter carriers* take the letters and packages from the mailboxes to a nearby post office.

Sorting. Outgoing mail is first sorted at the *originating post office,* the postal facility near the sender. There, postal clerks put the newly collected mail into trays. They bundle packages separately. From the post office, the mail travels by truck to a central facility, sometimes called a *management sectional center.* These centers process nearly all the mail coming from or going to their regions.

Workers called *mail handlers* empty the trays of mail onto moving conveyor belts. The belts carry the mail to a machine called an *edger-feeder,* which separates the mail according to envelope size. The edger-feeder moves the letters into another machine known as a *facer-canceler.* Sensing devices in the facer-canceler find the stamp or facer identification mark on the envelope. These sensors enable the machine to arrange the letters so they all face the same way. The facer-canceler cancels stamps by printing black lines over them so they cannot be used again.

Mail then moves to computerized machines called *optical character readers.* These machines "read" the address on a letter and then spray a pattern of lines and bars known as a *bar code* onto the envelope. Machines called *bar code sorters* then read the codes and sort the mail according to region. Some businesses print their own bar codes on their outgoing mail; these precoded items skip the optical character readers and go directly to the bar code sorters.

If an optical character reader cannot read the address on a piece of mail, the rejected mail may be sent for *remote video encoding.* In this process, an image of the address is scanned and stored in a computer, where computer programs and operators attempt to read the address. If the process succeeds, an operator codes the item and sends it to the bar code sorter. If the process does not succeed, the address is read by a human being, and the mail is sorted accordingly.

Mail addressed to locations outside the region served by the central facility travels by truck, airplane, or train to other central facilities. The mail is then sorted mechanically or by hand into bundles for each delivery route served by the center. Finally, postal workers transport the mail to local post offices for delivery.

Delivery. At local post offices, letter carriers receive the mail for businesses and homes along their routes. They arrange the mail in the order in which they will deliver it by putting it into cases that have slots for each address. In some areas, letter carriers receive mail that has already been sorted by a bar code sorter. Some letter carriers walk their entire route. Most letter carriers, however, drive cars or special postal service vehicles.

The history of postal services

Ancient times. Many ancient civilizations, including the Chinese, Egyptians, Assyrians, and Persians, had well-organized mail systems. These early postal networks existed to help rulers govern empires that stretched over large areas. Generally, only government officials could use the postal system. There was little demand for public mail service because few people could read or write.

Nearly all ancient postal systems were *relay systems.* They consisted of runners or mounted couriers stationed at intervals along major roads. Messages relayed by these couriers traveled swiftly, sometimes more than 100 miles (160 kilometers) a day. In the 500's B.C., the Persian Empire, based in what is now Iran, developed an efficient relay system of mail delivery by couriers on horseback. Herodotus, a Greek historian of the 400's B.C., described the Persian messengers by writing, "Neither snow/ nor rain/ nor heat/ nor gloom of night stays these couriers from the swift completion of their appointed rounds." These words are inscribed on the central post office building in New York City.

The most highly organized mail system of ancient times was established by Augustus Caesar, who became the Roman emperor in 27 B.C. It was a relay system in which mounted couriers rode throughout the empire on a network of well-constructed roads. Along the roads, the Romans built relay stations called *posthouses.* There, messengers could rest, get fresh horses, or pass their messages to another courier. In the A.D. 200's, Roman couriers began to deliver a limited amount of private mail, as well as official messages.

The fall of the West Roman Empire in the A.D. 400's led to the collapse of the postal system. Rulers in some areas continued to use Roman roads and posthouses for their own postal services. But generally, organized communication ended throughout Western Europe.

Meanwhile, many civilizations in other areas of the world developed efficient postal systems. In North and South America, the Aztec and the Inca established networks of relay runners, who delivered messages and packages between major cities. In Asia, the Mongol leader Kublai Khan developed a highly organized postal relay system, with more than 10,000 postal stations, during the 1200's.

The growth of public mail systems. During the 1300's, the growth of international commerce led merchants and trading companies to establish their own courier services. Universities, religious groups, and *guilds* (organizations of skilled workers) also maintained mail service for their members. However, service was slow, expensive, and unreliable.

The invention of the printing press and the growth of education and learning during the 1400's increased the demand for postal services. Delivering mail became a profitable business, and private mail services sprang up in many areas. The Thurn and Taxis family organized one of the most famous private systems in the Holy Roman Empire, which covered what are now Austria, the Czech Republic, Germany, the Netherlands, Switzerland, and part of Italy. Generally, however, service remained costly and slow. In addition, mail services only delivered mail along major transportation routes.

The rise of strong centralized governments in Europe in the late 1400's and the 1500's led to the establishment of official postal services. In 1477, King Louis XI of France created a postal system of mounted couriers with regular schedules. By the end of the 15th century, the Thurn and Taxis family resurrected the old Roman postal system and began what would become a courier service connecting the monarchs of Europe. In the early 1500's, King Henry VIII of England organized a courier system in his own country.

What happens to a letter

Mailing a letter to a friend is just the first step in a long, complicated process. Before your friend receives the letter, it will be handled by many people and numerous machines. The three main stages in the process are collection, sorting, and delivery.



© David R. Frazier

Mailboxes, also called *collection boxes,* are located alongside streets and inside buildings in many towns and cities. A person can mail a letter by dropping it into a mailbox.



© David R. Frazier

A postal employee called a *letter carrier* collects letters and packages from the mailbox. The carrier then transports the mail by truck to a nearby post office for sorting.



© David R. Frazier

Moving conveyor belts at a central mail-processing facility carry the mail to a machine called an *edger-feeder.* The edger-feeder separates items according to envelope size.



© David R. Frazier

A facer-canceler machine arranges the letters so they all face the same direction. It then prints lines over the stamps so they cannot be used again.



© David R. Frazier

A computerized optical character reader "reads" the address on each piece of mail. It then sprays a pattern of lines and bars called a *bar code* onto the envelope to indicate its destination.



U.S. Postal Service

A bar code sorter receives the mail after the optical character reader. The machine sorts the mail according to the destinations indicated by the bar codes.



U.S. Postal Service

A postal truck carries mail to other postal facilities nearer the mail's destination. Trucks may also take mail to airports, where it is then loaded onto airplanes.



U.S. Postal Service

Airmail is the fastest way to send letters and packages to distant places. Most mail going more than 200 miles (320 kilometers) travels by airplane.



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At the destination airport, workers take the mail from the airplane and load it onto trucks. The trucks then carry the mail to local postal facilities for delivery.



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At the postal facility, the mail is sorted and bundled for every delivery route served by the facility. Workers use mail carts to transport the bundled mail.



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A special postal service vehicle departs from the local post office and carries the mail on its delivery route. Some letter carriers do not use vehicles and instead walk their entire routes.



© Consignia

A letter carrier delivers the mail to its final destination. Many carriers park their vehicle on every block along the route and make deliveries on foot.

During the early 1600's, many European governments established public postal systems. In 1627, the French government established post offices in major cities and regulated postal rates. Many countries passed laws giving the government the sole power to provide postal delivery. However, private mail services continued to operate in these countries, mostly along routes not covered by government postal systems.

The creation of the Penny Post. The development of mail service in England soon surpassed that on the European continent. In 1635, King Charles I, motivated largely by the need to raise money, became the first English monarch to offer mail services to his subjects. In 1680, a merchant named William Dockwra organized the London Penny Post, which delivered mail anywhere in London for a penny. Dockwra introduced the practice of postmarking letters to indicate when and where they had been mailed. The London Penny Post became so successful that the government took control of the operation in 1682.

During the 1700's, a program to improve the condition of public roads in England greatly increased the speed at which mail traveled. In the late 1700's, the British government further improved postal service by sending mail on stagecoaches.

In 1837, a retired British schoolteacher named Rowland Hill wrote a pamphlet titled *Post Office Reform.* In it, he called for a uniform penny post, which would charge cheap, uniform postage rates, regardless of distance. At that time, the cost of sending a letter depended on how far it had to travel. Hill also proposed that postage should be paid in advance by the sender, with adhesive stamps to indicate payment. Previously, the letter carrier collected postage from the addressee unless postal officials had written "Paid" on the letter. In addition, Hill suggested the use of envelopes. Until that time, letters were merely folded and sealed with sealing wax. The British Post Office issued the first postage stamps in 1840 and later adopted many of Hill's other ideas. Following the introduction of the uniform penny post, the British system became the model for postal systems around the world.

During the middle and late 1800's, mail volumes increased dramatically. This expansion resulted in efforts to develop cooperation in postal communications between countries. In 1874, 22 countries attended an international postal conference in Bern, Switzerland, to organize and improve the flow of mail between nations. The conference established the General Postal Union, which began functioning in 1875. The name was later changed to the Universal Postal Union.

Postal service in the United States. The first official postal system in the American Colonies was established in 1639 in Boston. The Massachusetts Bay Colony gave a tavern owner named Richard Fairbanks the right to process mail to and from overseas locations. In 1691, King William III of England gave Thomas Neale, a colonial official, the sole right to provide postal services in the American Colonies. In 1707, the British government took control of Neale's system.

After the Revolutionary War in America (1775-1783) began, the Continental Congress named statesman and inventor Benjamin Franklin the first postmaster general of the United States. In 1789, after the nation had won its independence, Congress gave the federal government the sole power to provide postal services.

During the 1800's and early 1900's, postal services grew rapidly in the United States. In 1863, the U.S. Post Office Department began to provide free delivery in many cities. In 1918, airplanes began to carry mail regularly. In 1943, the department divided major cities into numbered postal zones. In 1971, Congress replaced the Post Office Department with the United States Postal Service, an independent agency in the executive branch of the government. For more information on the U.S. Postal Service, see **Postal Service, United States.**

Corbis/Bettmann





Granger Collection

The Penny Black was the world's first postage stamp. The British Post Office issued the stamp, with a picture of Queen Victoria, in 1840.

The use of stagecoaches to deliver mail began in the 1700's and greatly improved the speed of postal services. This photo shows a mail coach in London in the 1800's.



AP/Wide World

Private courier firms, such as Federal Express and the United Parcel Service, have taken much of the package shipment business away from government postal services.

Canadian mail service. The first organized postal service in Canada began in 1693, when Pedro da Silva transported letters between Montreal and Quebec City. At this time, most of Canada was controlled by either English or French colonists. In 1755, Canada's first government post office opened, under the administration of the British Post Office.

Canada took over responsibility for its postal services in 1851, and it created the Post Office as a department of the Canadian government in 1868. Canada won complete independence from the United Kingdom in 1931. The Canada Post Corporation Act, passed in 1981, created the Canada Post Corporation to operate the mail system.

Modern developments

Postal services in their modern form have resulted from a long line of advances, both cultural and technological. The introduction of steamboats, trains, automobiles, airplanes, and new machinery have been vital to the industry's growth since the 1800's. Since the mid-1900's, new developments have further improved the mail process in many ways, but they have also brought new challenges to the postal services.

Technological advancements. In the 1960's, many post offices began using high-speed equipment to perform much of the work previously done by hand. Since then, mail processing has gone through sustained technological innovation. The changes in technology in part stem from innovations in computers, telecommunications technology, and optical character reading.

A major application of these innovations has been the large-scale sorting of mail. Computerized machines, such as optical character readers and bar code sorters, enable post offices to quickly sort large amounts of mail with minimal costs. Many of these machines require fewer workers or less worker training, and some can be operated remotely.

Throughout this period of technological advancement, postal services had to contend with alternative methods of communication. Such innovations as the telegraph, telephone, and fax machine offered new, fast ways to share information. But although phone calls and faxes reduced the use of mail for certain types of communication, the demand for mail remained strong.

A new type of competition emerged in the 1990's, with the increased use of personal computers and the Internet. Computer users transmitted many messages that were once sent by mail by *e-mail* (electronic mail). In addition, many people began doing their shopping, banking, and business transactions over the Internet.

Competition from the Internet had a particularly great impact on traditional letter mail, known in the United States as first-class mail. This class of mail—used mainly for messages, invoices, and bills—is the class most easily replaced by electronic communication. The Internet also affected advertising mail, known in the United States as *standard mail,* as companies shifted some of their advertising to the World Wide Web. The demand for shipment of *parcels* (boxes and packages), on the other hand, grew with the rise of the Internet. This increased demand resulted, in part, because items purchased over the Internet still had to be shipped to the customer.

These changes have serious implications for the future funding of postal services and for the maintenance of universal service. If the demand for letter mail and advertising mail further decreases, as many experts expect, postal services worldwide may lose revenue and be forced to increase their rates and adjust their policies. Many postal systems, including the U.S. Postal Service, are themselves working to provide communication and bill payment by electronic means.

Competition and privatization. In addition to coming to terms with technological innovations like those just described, postal administrations face competition from private companies. For example, courier firms, such as the United Parcel Service, have taken much of the parcel business away from the United States Postal Service. Postal services are limited in their ability to raise parcel rates, because parcel shipment is not subject to the same monopoly protection that covers letter mail.

In addition, some private firms offer *presorting* services in competition with traditional mail services. Presorting refers to any sorting of mail that occurs before the postal service handles it. For example, a presorting company working for a newspaper or magazine, at least in the United States, may sort the mail and drop it off at the post office. Businesses find that they can afford presorting services, in part, because national post offices give a discount to mailers who presort their own mail.

A large number of people believe that mail delivery can function better as a competitive business than as a government monopoly. As a result, many countries have been *privatizing* their postal systems—that is, transferring certain operations and responsibilities from government agencies to privately owned companies. For instance, the Dutch Post Office is a private company with stock held both by the Netherlands government and by private individuals. Germany began to privatize its post office, Deutsche Post, in 2000. In other countries, a government postal administration may simply hire private firms to handle certain tasks.

Michael A. Crew and Paul R. Kleindorfer

Related articles in *World Book* include:

Airmail	E-mail
Comstock Law	Envelope

Fax machine
Franking and penalty privileges
Letter writing
Mail-order business
Money order
Parcel post
Pony express
Postal Service, United States
Postal Union, Universal
Rural delivery
Stamp
Stamp collecting
United Parcel Service
ZIP Code

Outline

I. **How mail is delivered**
  A. Collection
  B. Sorting
  C. Delivery
II. **The history of postal services**
III. **Modern developments**
  A. Technological advancements
  B. Competition and privatization

Questions

What are some of the machines post offices use to help them process mail more efficiently?
What were some of the innovations suggested by Rowland Hill?
What agency is the largest single employer of civilian labor in the United States?
What does it mean to have an obligation of universal postal service?
How has the Internet affected the demand for traditional letter mail? How has it affected the demand for shipment of parcels?
When did airmail service go into operation?
How did ancient relay systems work?
Who was the first postmaster general of the United States?
What is privatization?
How did the Thurn and Taxis family of Austria contribute to the development of mail service?

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Postal Union, Universal (UPU) is a specialized agency of the United Nations that sets rules for the free flow of mail between countries. It works to promote cooperation in organizing and improving postal services. The UPU provides postal technical assistance to its approximately 170 member countries, which make up a single postal territory for exchanging mail.

The UPU operates under an international agreement called the Universal Postal Convention. The convention lists postal rates and uniform procedures for handling first-class mail, including letters, post cards, and small packets. Under the convention, member countries set postal charges within specified limits. If a country's postal service receives a greater number of mail items than it sends, it is entitled to collect the cost of handling this excess mail from the sender country. Separate agreements govern other services, such as parcel post, newspaper and magazine subscriptions, insured letters and boxes, and money orders.

The Universal Postal Congress is the main legislative body of the Universal Postal Union. It usually meets every five years in a member country to review and amend the convention. UPU legislation takes precedence over any conflicting national laws. But, some provisions are optional.

The Executive Council is a permanent body that handles UPU affairs between congresses. It consists of 40 members, elected on the basis of geographical representation. The Consultative Council on Postal Studies conducts technical research in international postal matters. It has 35 members. The International Bureau is the UPU's permanent secretariat. The bureau may also act as an information center and clearinghouse for settling the financial accounts of the UPU.

The first international postal congress was held by 22 countries in 1874 in Bern, Switzerland. The first postal convention went into effect in 1875. The Universal Postal Union received its present name in 1878 at the second postal congress. The UPU became a specialized agency of the United Nations in 1947. The UPU has headquarters in Bern.

Critically reviewed by the Universal Postal Union

Poster is a printed sheet of paper or cardboard displayed in public. Most posters convey a simple message using words and illustrations. Posters may announce events, such as plays, films, or art exhibits. They may also advertise commercial products or convey political messages.

A typical poster emphasizes simple shapes, bright colors, and large letters to attract attention. Most posters are large enough to be seen from a distance. They are often posted on walls and places along streets where the public can easily see them. Many posters are so large that they are placed on billboards. Commercial posters are usually made by photography, lithography, and silk-screen printing.

Designing posters became popular with European artists in the 1800's. Beginning about 1866, the French artist Jules Chéret produced more than 1,000 large colorful posters using the recently invented process of color lithography. In the 1890's, the French artist Henri de Toulouse-Lautrec gained fame for the beautiful bold designs of the posters he made for theaters and dance halls. Many artists in the 1900's designed posters that are collected as works of art. Elizabeth Broun

See also **Advertising** (Outdoor signs); **China** (Communication; picture: Wall posters); **Poland** (picture: A huge poster); **Propaganda** (pictures); **Uncle Sam** (pictures).

Postimpressionism is the name applied to several styles of painting that arose in Western Europe, especially France, in the 1880's and 1890's. Postimpressionism followed the art movement known as Impressionism.

Impressionist painters sought to capture a direct experience of the natural world. They rebelled against the idealized, carefully finished paintings of the prevailing academic style. Unlike the academic painters, the Impressionists did not try to give their art a theoretical, moral, or emotional significance. The Postimpressionists attempted to move beyond the ideas and techniques of Impressionism. Postimpressionist painters added emo-

tional or symbolic meanings to their work. In this way they helped bring about the transition from impressionism's faithfulness to nature to Fauvism, cubism, and abstract styles of the 1900's.

The English art critic Roger Fry coined the term *postimpressionism* in 1910 for an exhibition of modern painting he organized in London. The most important postimpressionists were the French artists Georges Seurat, Paul Gauguin, and Paul Cézanne; and the Dutch painter Vincent van Gogh. Ann Friedman

Each painter mentioned in this article has a biography in *World Book*. See also **Impressionism; Painting** (Postimpressionism; pictures).

Postmodernism is a term often applied to artistic styles that emerged in the mid-1900's. Art critics and historians do not agree on exactly when Postmodernism started or who began it. They do generally agree that it developed as a reaction to and a rejection of a widespread style of the earlier 1900's called *modernism.*

Modernist artists and designers preferred simple, geometrical, and clean-looking forms that were uncluttered and practical. Modernism advocated geometrical abstraction and sleek, streamlined designs. Postmodern artists and designers revived the styles of older art movements. Through this revival, Postmodernism introduced complexity, figurative ornament, and cluttered or mixed-up forms. Modernism stressed originality, newness, and the economy of line, shape, and color. Postmodernism stressed the revival of tradition, and often featured the plentiful use of texture, shape, color, or line. Modernist art emphasized individual expression. Postmodern art stressed collective or shared expression through collaboration and a blend of borrowed styles called *pastiche.*

In the fine arts, Postmodernism is probably most visible in the works of several American architects. A typical Postmodern building reflects elements of historical styles ignored by earlier modern architects. Unlike modernist structures, Postmodern buildings often feature ornamentation on their exteriors. The most notable Postmodern architect and theorist is Robert Venturi. Other Postmodern architects include Peter Eisenman, Michael Graves, Philip Johnson, Charles Moore, Robert Stern, James Stirling, and Stanley Tigerman.

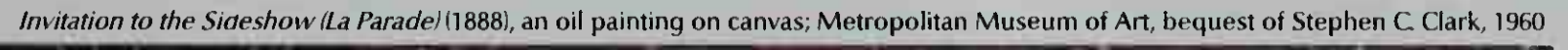
Social critics have also used the term *Postmodernism* to define changes in our way of life. For example, a Postmodern society is more decentralized, fragmented, and impermanent than a modernist society. The characteristics of a Postmodern society can be seen in the fragmentary poetry of the American writer John Ashbery, in the experimental works of the American composer John Cage, and in the symbol-filled pictures of the American photographer Cindy Sherman. Herman Rapaport

Related articles in *World Book* include:

Architecture (Architecture today)
Ashbery, John
Cage, John
Furniture (Postmodern design)
Graves, Michael
Jahn, Helmut
Johnson, Philip Cortelyou
Venturi, Robert

Post-traumatic stress disorder is a psychological illness in which people repeatedly remember, relive, or dream about a terrible experience. The disorder may result from experiencing or witnessing a natural disaster, warfare, a personal assault, or any other violent or life-threatening incident. Because many soldiers involved in combat develop the disorder, it was formerly known as *battle fatigue, combat fatigue,* or *shell shock.*

A person with post-traumatic stress disorder (PTSD) experiences symptoms for more than one month following a psychological *trauma* (severely upsetting event). The chief symptoms of PTSD include repeated dreams, memories, and *flashbacks* (vivid, involuntary recollections) of the incident. Other symptoms include sleeplessness, difficulty concentrating, and being easily startled. Emotional signs include feelings of anger, fear,


Invitation to the Sideshow (La Parade) (1888), an oil painting on canvas; Metropolitan Museum of Art, bequest of Stephen C. Clark, 1960



Postimpressionism followed Impressionism as a major art movement in the late 1800's. One of the leading Postimpressionist painters was Georges Seurat of France. He developed a style called *pointillism* in which the artist creates a painting by placing dots of pure color side by side. The painting at the left shows Seurat's pointillist style. Other Postimpressionist artists developed their own styles.

helplessness, or guilt. Some patients develop emotional numbness and feelings of isolation from others. Children may show restlessness, repeat the trauma in play, or have frequent nightmares.

PTSD may persist for many years. Some people held as prisoners of war or concentration camp inmates during World War II (1939-1945) showed symptoms of the condition more than 50 years later. Treatment of PTSD involves psychotherapy and, often, medication. Prompt treatment following the trauma may help prevent PTSD or lessen its severity. Theodore Nadelson

Postulate. See Geometry (Axiomatic organization).

Posture is the position of a person's body while standing or sitting. Posture is determined by the person's ability to maintain balance against the force of gravity, which constantly pulls the body downward. The action of certain muscles keeps the body upright. These muscles include those that keep the back, hips, and knees from bending. Because of the constant give and take of the pull of gravity and of muscle action, posture is a dynamic, ever-changing state.

Good posture requires the least amount of muscle activity to breathe well and to maintain an upright position. The feet should be placed comfortably apart, with the weight distributed evenly over both feet. From a front or back view, the shoulders, the hips, and the fingertips should be approximately aligned. From a side view, the ear and the shoulder should be aligned, and that line projected downward should fall in front of the middle of the knee. The back should not be excessively arched. The arches of the feet should be visible without conscious effort.

Posture is an indication of the way people have stood or sat for much of their lifetime. If a person constantly stands or sits with the head hanging forward, the neck muscles change in length, and good posture becomes hard. All body parts work together, so getting one part, such as the head, out of alignment will cause other parts also to be out of alignment. The further away one's body parts are from the body's center of gravity, the more the muscles will have to work to keep the body upright. When this happens, fatigue and stress result.

Posture also may indicate the way people feel. If they are tired or depressed, their posture may be poorer than usual. Changes in posture may affect a person's appearance, gait, and personality. Good posture gives an impression of poise and self-confidence, and may allow the body to function at its best. Learning about body function and body relaxation can help improve posture.

Mary T. Moffroid

Pot, a drug. See Marijuana.

Potash, *PAHT ash,* is the commercial name for a group of salts containing the element potassium. The most important type of potash is *potassium chloride* (KCl), which is mainly used to make fertilizer. About 95 per cent of the potash that is processed throughout the world is refined for fertilizers. Potash is also used in the manufacture of soaps and detergents, glass, ceramics, textiles, dyes, chemicals, and drugs.

The mineral sylvite is the chief potash ore. Most potash ore is found in underground salt beds that formed when ancient seas evaporated. The deposits are usually obtained by a method of mining called the *room-and-pillar* system (see Mining [Underground mining methods]). Potash also occurs in salt lakes. Potash is graded according to its *potassium oxide* (K_2O) *equivalent,* a standard that measures potassium content. The K_2O equivalent is also used to determine how much potash a mine will produce.

Potash was originally obtained by running water through wood ashes and boiling the resulting solution in large iron pots. The substance that formed, *potassium carbonate* (K_2CO_3), was called *pot ash.* The United States imports two-thirds of its potash supply from Canada. Most of the potash produced in the United States comes from New Mexico. Robert J. Ouellette

See also Potassium.

Potassium, *puh TAS ee uhm,* is a silvery metallic element. It reacts readily with both oxygen and water. In nature, because of this characteristic, potassium always occurs combined with other elements. It is found in the form of minerals, such as carnallite and sylvite. Sir Humphry Davy, an English chemist, first isolated potassium as a pure metal in 1807.

Potassium, with a density of 0.856 gram per cubic centimeter at 20 °C, is the lightest metal except lithium (see Density). It is so soft that it can be cut with a knife. Potassium has an atomic number of 19 and an atomic weight of 39.0983. Its chemical symbol is K. Potassium belongs to the group of elements called *alkali metals* (see Element, Chemical [Periodic table of the elements]). It melts at 63.2 °C and boils at 766 °C. One isotope of the element, potassium-40, is radioactive. The age of a substance can often be determined by analyzing the amount of potassium-40 it contains.

Potassium is a relatively abundant element and makes up nearly $2\frac{1}{2}$ percent of the earth's crust. Large deposits of its principal compounds, including potassium chloride and potassium sulfate, occur in parts of Canada and Germany. The Dead Sea is another major source of potassium compounds.

Scientists have developed a wide variety of uses for potassium and its compounds. Potassium metal, used chiefly in sodium-potassium alloys, is usually obtained from molten potassium chloride through a special chemical process. These alloys, which are liquids at room temperature, are used in the heat-transfer systems of some types of nuclear reactors called *fast breeders.* Manufacturers use potassium carbonate, also called *potash,* in making certain kinds of glass and soaps. They use potassium nitrate, known as *saltpeter,* in producing matches and explosives. Some potassium compounds are used for medical purposes. For example, potassium bromide is a sedative, and potassium iodide promotes the discharge of mucus from the nose and from the throat.

Plants require potassium for growth. Therefore, soil must contain potassium compounds to produce crops of high quality and yield. Potassium chloride is widely used in commercial fertilizers for most crops. But potassium sulfate is a better fertilizer for tobacco and crops that would be harmed by chloride.

Potassium also is essential for human beings and other animals. It plays a part in *metabolism,* the process by which organisms change food into energy and new tissue. For example, potassium helps enzymes speed up some chemical reactions in the liver and the muscles. Such reactions produce an important carbohydrate

called *glycogen,* which regulates the level of sugar in the blood and helps provide energy for the muscles. Potassium, together with sodium, also contributes to the normal flow of water between the body fluids and the cells of the body. A daily diet that includes fruit, vegetables, and meat supplies enough potassium for the normal needs of the human body. Duward F. Shriver

See also **Alkali; Fertilizer** (Inorganic fertilizers); **Potash; Saltpeter.**

Potassium-argon dating. See Archaeology (Dating).

Potassium nitrate. See Saltpeter.

Potato is one of the world's most widely grown vegetables and most important foods. Potatoes have a high nutritional value and are grown in most countries.

Potatoes are prepared in various ways—baked, boiled, French-fried, fried, and mashed—and are served with meat or fish and with other vegetables. Food processors make potatoes into potato chips, instant mashed-potato powder, and other products. Food canners use potatoes in such foods as hash, soup, and stew. Other products whose ingredients may include potatoes are alcoholic beverages, flour, and certain starches used in industry.

A potato consists of about 80 percent water and 20 percent solid matter. Starch makes up about 85 percent of the solid material, and most of the rest is protein. Potatoes contain many vitamins, including niacin, riboflavin, thiamine, and vitamin C. They also contain such minerals as calcium, iron, magnesium, phosphorus, potassium, sodium, and sulfur.

Potatoes are not especially fattening unless flavored with butter, gravy, or sour cream. An average-sized baked potato that weighs from 6 to 8 ounces (170 to 225 grams) contains fewer than 100 calories.

Russet Burbank | Norchip | Kennebec | Katahdin

Irish Cobbler | Red LaSoda | Red Pontiac | White Rose

WORLD BOOK illustration by James Teason

Potatoes rank among the most important and nutritious of all foods. People prepare them in many different ways. Eight of the several hundred potato varieties are illustrated here.

The world's potato growers produce about 340 million tons (310 million metric tons) of potatoes annually. China grows more potatoes than any other country. Other leading potato-growing countries include India, Poland, Russia, Ukraine, and the United States.

The United States produces more than 20 million tons (18 million metric tons) of potatoes yearly. Idaho and Washington are the leading potato-growing states. Among the Canadian provinces, Prince Edward Island is, by far, the leading potato producer.

Leading potato-growing countries

Tons of potatoes produced in a year	
China	67,509,000 tons (61,243,000 metric tons)
Russia	36,135,000 tons (32,781,000 metric tons)
India	27,047,000 tons (24,537,000 metric tons)
United States	23,920,000 tons (21,700,000 metric tons)
Poland	23,722,000 tons (21,520,000 metric tons)
Ukraine	16,925,000 tons (15,354,000 metric tons)
Germany	14,116,000 tons (12,806,000 metric tons)
Belarus	9,152,000 tons (8,303,000 metric tons)
Netherlands	9,039,000 tons (8,200,000 metric tons)
United Kingdom	7,505,000 tons (6,809,000 metric tons)
France	7,288,000 tons (6,611,000 metric tons)

Figures are for a three-year average, 1999-2001.
Source: Food and Agriculture Organization of the United Nations.

Leading potato-growing states and provinces

Tons of potatoes produced in a year	
Idaho	7,061,000 tons (6,406,000 metric tons)
Washington	4,940,000 tons (4,481,000 metric tons)
Wisconsin	1,645,000 tons (1,492,000 metric tons)
Prince Edward Island	1,458,000 tons (1,323,000 metric tons)
Colorado	1,448,000 tons (1,314,000 metric tons)
Oregon	1,416,000 tons (1,285,000 metric tons)
North Dakota	1,367,000 tons (1,240,000 metric tons)
Minnesota	1,007,000 tons (914,000 metric tons)
Manitoba	962,000 tons (873,000 metric tons)
Maine	897,000 tons (814,000 metric tons)
California	770,000 tons (699,000 metric tons)

Figures are for a three-year average, 1998-2000.
Sources: U.S. Department of Agriculture; Statistics Canada.

Several hundred kinds of potatoes are grown in the United States. The *Russet Burbank* ranks as the most popular variety. People eat Russet Burbanks fresh and as processed potato snacks. Another variety, the *Russet Norkotah,* is sold mostly in the fresh potato market. The *Ranger Russett* and *Shepody* potatoes most commonly appear in processed foods. Other potato varieties include the *Cobbler, Katahdin, Kennebec, Norchip, Red La-Soda, Red Pontiac,* and *White Rose.*

The potato plant

The edible parts of a potato plant are growths called *tubers,* which form underground on the stems. Most potato plants have from 3 to 6 tubers. Some have from 10 to 20, depending on the variety, the weather, and soil conditions. Potatoes are round or oval and rather hard. They may grow more than 6 inches (15 centimeters) long and weigh as much as 3 pounds (1.4 kilograms). Their skin is thin and may be brown, reddish-brown, pink, or white. The inside of a tuber is white, and potatoes are often called *white potatoes* to distinguish them from a vegetable called the *sweet potato.*

Tubers consist of several layers of material. The outer skin is called the *periderm.* The next layer, the *cortex,* serves as a storage area for protein and some starch. The third layer, known as the *vascular ring,* receives starch from the plant's leaves and stem. The starch moves out of the vascular ring to surrounding tissue made up of *parenchyma cells.* These cells are the tuber's main storage areas for starch. The center of the tuber, called the *pith,* consists mostly of water.

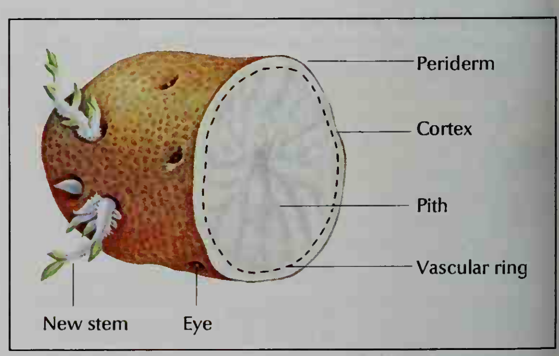
The part of the plant that grows aboveground has spreading stems and coarse, dark green leaves. The potato plant grows from 3 to 4 feet (90 to 120 centimeters) tall. It has pink, purple, or white flowers that appear three or four weeks after the plant starts to grow aboveground.

The flowers of potato plants develop seedballs that resemble small green tomatoes. Each seedball contains about 300 yellowish seeds. Scientists use these seeds in developing new varieties of potato plants.



WORLD BOOK illustration by James Teason

A potato plant has leafy stems and pink, purple, or white flowers. From 3 to 20 growths called *tubers* form underground on the stems. The tubers are the edible parts of the plant.



WORLD BOOK illustration by James Teason

A cross section of a potato shows several layers of material. Each layer serves a function essential to the proper growth of the plant. Stems sprout from the eye of a tuber.

Growing potatoes

Planting and cultivating. Potatoes must be replanted annually because the plants die after the tubers mature. Potato plants grow best in areas where the temperature usually ranges from 60 to 70 °F (16 to 21 °C).

In the United States, potatoes are grown commercially in nearly every state. Farmers in the Southern States generally plant potatoes from September through March. In such Midwestern States as Kansas and Missouri, potatoes usually are planted in March, April, and May. In the Northern States, farmers plant potatoes in late spring and early summer. The tubers mature in 90 to 120 days, depending on the variety.

Most potato growers plant small, whole tubers and segments called *seedpieces,* which weigh about 1 ½ ounces (42 grams) and are cut from tubers. The whole tubers and the seedpieces are both known as *seed potatoes.* Each seed potato has at least one *eye* (bud) from which the stems grow both above and below the ground. Whole tubers are the best seed potatoes because they are less likely to rot and become diseased than seedpieces. Before planting seed potatoes, farmers spray them with fungicides to reduce the possibility of disease.

Commercial potato growers use machines that plant up to six rows of seed potatoes at a time. The seed potatoes are planted from 2 to 4 inches (5 to 10 centimeters) deep and 6 to 20 inches (15 to 51 centimeters) apart. The rows are planted from 30 to 36 inches (76 to 91 centimeters) apart. Potato growers plant 20 to 30 bushels of seed potatoes per acre (49 to 74 bushels per hectare).

Potatoes grow best in *loam,* a type of soil whose tex-



Lockwood Corporation

A potato combine digs up potato plants and separates the tubers from the soil. The potatoes are loaded automatically into a truck and taken to a packing shed. Then they are washed and packed for shipment or stored in warehouses.

ture varies between that of clay soil and sandy soil. The loam should be *aerated* (mixed with air), well-drained, and enriched with fertilizer. Farmers occasionally cultivate the soil around the growing plants. Cultivation helps aerate the soil, kill weeds, and supply soil covering for the growing tubers. Potato growers use two basic methods of cultivation, *ridge,* or *hill, culture* and *level culture.*

Ridge culture is the most common method of cultivation. Farmers use a cultivator to build small hills over the seed potatoes. The hills, which stand from 6 to 8 inches (15 to 20 centimeters) high, protect the tubers from sunburn or frost.

Level culture is used mostly in areas where growers plant the seed potatoes deep in the soil. They are planted in a deep furrow, which the farmer gradually fills as the plants grow.

After the flowers drop off a potato plant, some farmers spray the leaves frequently with chemicals to prevent the tubers from sprouting after being harvested. In certain areas, particularly in the Northern States, farmers sometimes destroy the leaves before the plants reach maturity. The farmers do this so they can harvest the potatoes before frost or disease hits the plants.

Harvesting. Most commercial potato growers use potato combines to harvest their crop. These machines dig the plants out of the ground, separate the tubers from the soil, and load the potatoes into trucks. The combines dig up two to four rows at a time.

The potatoes are collected and then taken to a packing shed to be washed and packed for shipment. Bruised or diseased potatoes are discarded, and the rest are graded according to size. Some potatoes are shipped directly to food-processing plants or supermarkets. But most potatoes are stored in warehouses at temperatures ranging from 40 to 50 °F (4 to 10 °C). The stored potatoes can be marketed as long as a year after being harvested.

Diseases and insect pests. Several diseases may attack potato crops. They include such fungus and bacterial diseases as *late blight, rhizoctonia, ring rot,* and *scab* and such virus conditions as *leafroll, mosaic,* and *spindle tuber.*

Late blight is controlled by spraying or dusting the plants with certain fungicides. Rhizoctonia and scab may be partially controlled by planting healthy seed potatoes. Ring rot can be controlled only by the use of disease-free seed potatoes. Virus diseases are best controlled by removing any diseased plants or tubers from the field and by using healthy seed potatoes.

The chief insects that attack potato plants include *aphids, flea beetles, leafhoppers, potato beetles,* and *potato psyllids.* The tubers are attacked by various insects, including *cutworms, grubs, potato tuber worms,* and *wireworms.*

Insects that feed on potato plants can be controlled by spraying insecticides into the furrow at planting time. The roots absorb the insecticides and transport them to the stems and leaves. The pesticides kill insects that feed on the leaves. Other insecticides may be sprayed directly on the leaves. Insects that attack tubers are controlled by spraying insecticides into the soil before planting.

History

The potato originated in South America. Botanists believe the white potato comes from a species that first grew in Bolivia, Chile, and Peru. Hundreds of years ago, the Inca Indians of those countries grew potatoes in the valleys of the Andes Mountains. From these potatoes, the Inca made a light, floury substance called *chuño.* They used chuño instead of wheat in baking bread.

Spanish explorers in South America were the first Europeans to eat potatoes. The Spaniards introduced them into Europe in the mid-1500's. About the same time, English explorers brought potatoes to England. From there, potatoes were introduced into Ireland and Scotland. They became the principal crop of Ireland because they grew so well there. In fact, the potato became known as the *Irish potato* because such a large part of the Irish population depended on it for food.

White potatoes were probably introduced into North America in the early 1600's. However, they did not become an important food crop until after Irish immigrants brought potatoes with them when they settled in Londonderry, New Hampshire, in 1719.

From 1845 to 1848, Ireland's potato crop failed because of late blight. Due to this and other factors, about 1 million Irish people died of disease or starvation. About 1 $\frac{1}{4}$ million others left Ireland and settled in other countries, chiefly the United States. Since the 1980's, new strains of late blight have reduced potato harvests throughout the world.

During the 1900's, the development of food processing has resulted in a tremendous use of potatoes in making such products as French fries and potato chips. Today, processing plants use about 80 percent of the potatoes grown in the United States. Hugh C. Price

Scientific classification. The white potato belongs to the nightshade family, Solanaceae. It is *Solanum tuberosum.*

Related articles in *World Book* include:

Burbank, Luther	Potato beetle	Sweet potato
Fungicide	Solanum	Tuber
Nightshade	Starch	

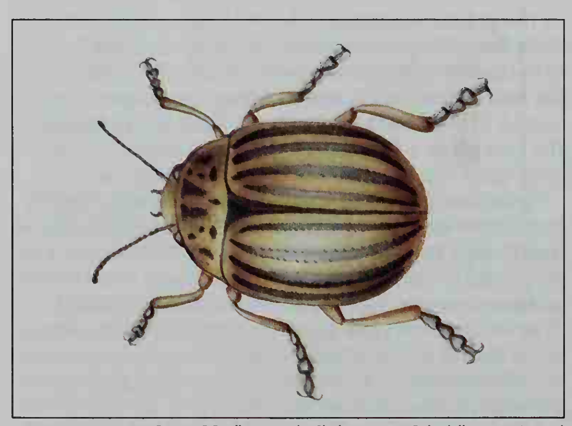
Potato beetle is the name of a group of beetles that attack potato plants. The beetles damage potato plants by feeding on the leaves and stems, and by transmitting such diseases as spindle tuber and root rot. The best-known species is the *Colorado potato beetle,* which probably originated in Mexico. When potatoes were first grown in the western United States, the beetle spread from its original food plant, the buffalo bur, to the potato plant. It is now found throughout the United States and parts of Canada.

Adult Colorado potato beetles measure about $\frac{1}{2}$ inch (13 millimeters) long. They are plump and yellow and have five black stripes on each wing cover. Adult beetles lay yellow eggs in clusters on the undersides of potato leaves. Larvae that hatch from the eggs are soft and orange-red in color. They feed on the leaves for about three weeks, then drop from the plant and burrow into the ground to become *pupae* (see **Pupa**). About 10 days later, the adults emerge. Two or three generations of beetles may be produced in one year.

The Colorado potato beetle is a difficult pest to control. A variety of insecticides have been used, but the beetles have gradually developed resistance to most of these chemicals. Enemies of the Colorado potato beetle include stinkbugs, toads, snakes, and birds.

John R. Meyer

Scientific classification. Potato beetles belong to the leaf beetle family, Chrysomelidae, in the order Coleoptera. The Colorado potato beetle is *Leptinotarsa decemlineata.*



WORLD BOOK illustration by Shirley Hooper, Oxford Illustrators Limited

Grant Heilman



The Colorado potato beetle deposits its eggs on potato plants. The larvae then feed on the tender leaves, damaging the plant, as shown in the photograph. Potato beetles are found in nearly every state.

Potato famine. See Ireland (The potato famine).

Potawatomi Indians, *PAHT uh WAHT uh mee,* belonged to the Algonquian language group of eastern forest tribes. They were closely allied with the Chippewa and Ottawa. These three tribes formed a confederacy known as "the three fires." In early days, the Potawatomi lived near the northern shores of Lake Michigan, from the eastern end of Lake Superior to Green Bay, Wisconsin, and in other areas around Lake Michigan. By 1700, groups of Potawatomi had moved into the Chicago and Detroit areas. Major groups lived along the St. Joseph River in Michigan and Indiana.

The Potawatomi raised corn, made maple sugar, and hunted buffaloes. They lived in dome-shaped lodges covered with bark. Early travelers described the Potawatomi as being polite and more civilized than other tribes of the area. Many Potawatomi became Christians.

The Potawatomi sided with the French until the end of the French and Indian wars. They took a prominent part in the Indian rebellion under Pontiac (see **Indian wars** [Along the frontier]; **Pontiac**). They fought with the British against the Americans in the Revolutionary War and the War of 1812. A group of Potawatomi and their Chippewa and Ottawa allies ambushed the retreating garrison of Fort Dearborn in Chicago in August 1812 (see **Fort Dearborn**). After the war, these Indians became friendly with American settlers. In the 1830's, the U.S. government moved the three tribes from their lands in Illinois to regions west of the Mississippi River. The tribes were the last Indians to leave Illinois.

Today, Potawatomi live throughout the United States, but mainly in Wisconsin, Indiana, Michigan, Oklahoma, and Kansas. Potawatomi also live in Ontario, Canada, and in several other countries. Francis Levier

Potential energy. See Energy.

Potentiometer, *puh TEHN shee AHM uh tuhr,* is a device that measures electric current, voltage, and resistance with high precision. It shows voltage differences by comparing an unknown electromotive force with a known one. It is used to calibrate voltmeters or ammeters, and as a control element in electronic circuits and devices. Robert B. Prigo

Potlatch. See **Indian, American** (Indians of the Northwest Coast).

Potomac River, *puh TOH muhk,* is a beautiful and historic stream that forms the boundary between Maryland, West Virginia, and Virginia. It winds 287 miles (462 kilometers) in a southeast course from its source in the Allegheny Mountains to its mouth in the Chesapeake Bay (see **Virginia** [political map]). Large ships can sail inland for 115 miles (185 kilometers) to Washington, D.C. The Potomac is from 2 to 7 miles (3 to 11 kilometers) wide for its last 100 miles (160 kilometers). It drains an area of 14,500 square miles (37,550 square kilometers).

The historic Potomac breaks through the Blue Ridge Mountains at Harpers Ferry, the scene of John Brown's Raid. The river also flows past Mount Vernon, the home of George Washington. Michael P. O'Neill



Jim Howard, FPG

The Potomac River flows past Washington, D.C. The Arlington Memorial Bridge connects Washington to Virginia.

See also **Chesapeake and Ohio Canal; Harpers Ferry; Washington, D.C.** (map).

Potsdam (pop. 138,737) is a German city that stands on the Havel River, about 15 miles (24 kilometers) southwest of Berlin. For the location of Potsdam, see **Germany** (political map).

Potsdam's leading economic activities include engineering and the production of chemicals, processed foods, and textiles. Flower growing is also an important industry, especially the cultivation of winter violets. Broad squares and public gardens add to the city's beauty. John W. Boyer

See also **Potsdam Conference.**

Potsdam Conference was the last meeting among the leaders of the United Kingdom, the Soviet Union, and the United States during World War II (1939-1945). It opened at Potsdam, Germany, near Berlin, on July 17, 1945, about two months after Germany's defeat in the war. Present at the opening were U.S. President Harry S. Truman, British Prime Minister Winston Churchill, and Soviet Premier Joseph Stalin. Clement Attlee succeeded Churchill as prime minister on July 26 and represented the United Kingdom for the rest of the conference, which ended on August 2.

Earlier agreements had divided Germany into British, French, Soviet, and U.S. occupation zones. At Potsdam, the participants agreed to treat the country as a whole in economic matters. The Soviet Union received a third of Germany's ships and some industrial equipment as payment for war damages. The participants also agreed to prosecute German leaders for war crimes (see **Nuremberg Trials**). While at Potsdam, Truman learned of the first successful atomic bomb test. That news led to the Potsdam Proclamation, threatening the destruction of Japan unless it stopped fighting the Allied nations and surrendered without conditions.

At Potsdam, the U.S. and British leaders charged that the Soviet Union had helped establish Communist governments in the countries of Eastern Europe that it had freed from German control. This criticism clearly showed a serious division among the members of the wartime alliance. Diane Shaver Clemens

See also **Truman, Harry S.** (picture).

Potter, Beatrix (1866-1943), was an English author and illustrator known for her charming children's stories about small animals. Her books combine stories of adventure and humor with delicate water colors that capture the action and mood of the text. Potter's first and most famous story is *The Tale of Peter Rabbit* (1902).

Potter wrote and illustrated about 25 books. In addition to Peter Rabbit, her characters include Squirrel Nutkin, Benjamin Bunny, Tom Kitten, Jemima Puddle-Duck, the Flopsy Bunnies, and Pigling Bland.

Helen Beatrix Potter was born on July 28, 1866, in London to wealthy parents. She began drawing plants and animals as a child. Potter based many of her illustrations on the animals and rural landscapes of the Lake District of northern England. Marilyn Fain Apseloff

See also **Literature for children** (picture: The first modern picture book).

Potter, Harry, is the boy hero of a spectacularly popular series of fantasy novels for children. The author is J. K. Rowling, an English writer.

Rowling introduced Harry in *Harry Potter and the Philosopher's Stone* (1997), her first published book. The novel became an immediate best seller in both the United Kingdom and the United States, where it was published in 1998 as *Harry Potter and the Sorcerer's Stone.* Also best sellers are *Harry Potter and the Chamber of Secrets* (1998), *Harry Potter and the Prisoner of Azkaban* (1999), and *Harry Potter and the Goblet of Fire* (2000). The motion-picture version of *Harry Potter and the Sorcerer's Stone* (2001) set box-office records.

The Harry Potter series is unique in publishing because of its widespread popularity among both adults and young people. Some literary critics proclaim the novels to be classics of children's literature.

Harry Potter begins the series as an 11-year-old boy. He grows one year older in each succeeding book. Rowling plans the series to run to seven novels.

After the wicked sorcerer Lord Voldemort murders Harry's parents, the orphaned boy is raised by his nasty Aunt Petunia and Uncle Vernon Dursley. Harry learns he is a wizard and is invited to attend the Hogwarts School of Witchcraft and Wizardry to study magic skills. He survives one danger after another, accompanied by his friends Ron and Hermione. Their adventures include encounters with a magical flying car, ghosts, giants, magic spells, and hostile classmates and teachers. All the stories mix suspense with humor. Zena Sutherland

See also **Rowling, J. K.; Literature for children** (picture: *Harry Potter and the Goblet of Fire*).

Potter's field is a free burial ground for strangers, criminals, and people too poor to pay funeral expenses. The Bible tells of the first plot of ground known as a potter's field. After Judas Iscariot betrayed Jesus Christ to the high priests of Jerusalem for 30 pieces of silver, he returned the money to the priests. They would not use the money for their Temple. Instead they bought "the potter's field to bury strangers in" (Matthew 27:7). Scholars believe this field was in the Valley of Hinnom, near Jerusalem. The term *potter's field* was widely used in the United States during the 1800's. Richard A. Kalish

Pottery is a type of decorative or useful ware made of baked clay. It ranges from valuable works of art to dinnerware, vases, and other simple household items. The word *pottery* also means a factory that makes pottery.

A piece of pottery may be mass-produced, or it may be the only one of its kind. Since ancient times, potters



Smithsonian Institution, Freer Gallery of Art, Washington, D.C.

Chinese pottery of the Song dynasty (A.D. 960-1279), such as this porcelain vase, ranks among the most beautiful in the world. A gray-green glaze provides the rich color.

have shaped and *fired* (baked) clay to make pottery. Some pottery in museums is thousands of years old and still in good condition.

Pottery belongs to a large group of items called *ceramic products.* Such products are made from materials known as *ceramics.* Ceramic products, in addition to pottery, include bricks, cement, grinding tools, sewer pipes, and other products used in industry. For more information on the products and processes of the ceramics industry, see the *World Book* article on **Ceramics.**

Types of pottery

The three major types of pottery are (1) earthenware, (2) stoneware, and (3) porcelain. Pottery is classified according to the mixture of clays that it contains and the temperature at which the mixture is fired. The firing temperature affects both appearance and strength.

Earthenware is a widely used type of pottery made largely from a mixture of earthenware clays. Such clays are found in soil in all parts of the world. Many people prefer earthenware because of the colorful *glaze* (glassy coating) which is applied to it. This pottery, like most bright, colorful glazes, is baked at a low temperature. Other types of pottery are less colorful because they are fired at a high temperature that harms most colorful glazes. Earthenware breaks and chips more easily than other types of pottery.

Stoneware is a hard, heavy kind of pottery made mostly from a mixture of stoneware clays. These clays are found in the soil of scattered areas of the United States. Potters fire such clays at extremely high temperatures. The heat causes the surface of stoneware to become glossy, and so many potters do not glaze it. Stoneware is stronger and heavier than earthenware. Like earthenware and some kinds of porcelain, it is *opaque*—that is, light cannot shine through it.

Porcelain is the purest and the most delicate type of pottery. There are two types of porcelain. *Hard paste porcelain* is fired at high temperatures. *Soft paste porcelain,* which includes chinaware, is fired at lower temperatures.

Potters make porcelain from a mixture that includes flint, a mineral called *feldspar,* and large amounts of kaolin. Kaolin is a fine, white clay, and so most porcelain fires to a delicate shade of white. Light can shine through a thin piece of porcelain. See **Kaolin.**

How pottery is made

There are four basic steps in making pottery: (1) preparing the clay, (2) shaping the clay, (3) decorating and glazing, and (4) firing.

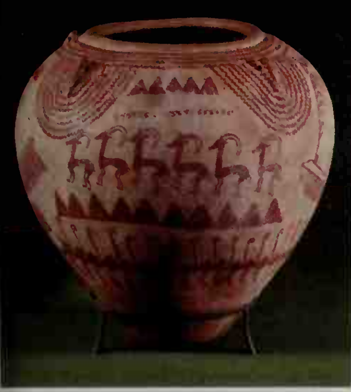
Preparing the clay. Potters prepare clay by pressing and squeezing it with their hands or by mechanical methods. This treatment makes clay soft and smooth, and it eliminates air bubbles that could cause the clay to crack during the firing process.

Shaping the clay can be done by various methods. Some of these methods involve *hand building,* in which potters use only their hands to shape the clay. The easiest hand-building method consists of pinching the clay into the desired form. Many beginning potters use this process to make small bowls called *pinch pots.* Another method of hand building, called *solid forming,* consists of shaping a sculpture out of a lump of clay.

The most common ways of shaping clay include (1) the coil method, (2) the slab method, (3) the mold method, and (4) the wheel method. The first two methods involve hand building, and the second two require equipment. A potter may use a combination of these methods. For example, the potter might form the body of a teapot on a potter's wheel and use a hand-building method to make the handle and spout.

The coil method is one of the oldest and simplest ways of making pottery. After preparing the clay, the potter shapes part of it into a flat piece that will be the base of the ware. The remaining clay is rolled into long strips. Using the base piece as a foundation, the potter coils the strips of clay on top of one another.

The coils must be attached together to make the pottery strong. The potter attaches each coil layer to the



The Metropolitan Museum of Art, New York City, Rogers Fund, 1920

An Egyptian earthenware bowl, made between 3200 and 3000 B.C., shows an arrangement of animals and hills.



The Museum of Ife Antiquities, Ife, Nigeria (Frank Willett)

An African terra-cotta head honors a ruler of the old kingdom of Ife, in Nigeria. It was created in the A.D. 1100's.



Dyson Perrins Museum, Worcester, England

An English porcelain teapot of about 1760 had a design strongly influenced by Chinese porcelain.



The Metropolitan Museum of Art, New York City, Rogers Fund, 1920

small Greek flask of the 500's B.C. ꞏld cleansing oils. The terra-cotta flask ꞏas carried on a wrist strap.



The Metropolitan Museum of Art, New York City, Fletcher Fund, 1946

An Italian majolica dish of the A.D. 1400's was decorated with detailed designs and covered with a white glaze.



Collection of the artist, Ruth Duckworth

A contemporary vase, made of white stoneware, consists of four vases of different sizes that form a unit.

ꞏxt with a creamy substance called *slip.* Slip, which ꞏrves as a cement, is made by adding water to clay. Potꞏrs always smooth the inside surface of a piece of coil ꞏttery. They may also smooth the outside surface, deꞏnding on the design of the piece.

The slab method forms pottery from flat pieces of ꞏay. The potter shapes the clay into flat slabs by poundꞏg it with the fists or by flattening it with a rolling pin. ꞏsing one slab as the base, the potter places other slabs ꞏright angles to it to form the sides of a piece of potꞏry. The slabs are then attached together with slip. ꞏabs may be difficult to work with, especially if they are ꞏge. For this reason, the potter may let the slabs ꞏrden slightly before fastening them together.

The mold method is used to produce identical pieces ꞏpottery. One technique of mold shaping, called *slip casting,* is used to turn out a large number of pieces of hollow pottery. In slip casting, the potter pours slip into a mold and lets part of it dry. The slip nearest the sides of the mold thickens quickly. After a few minutes, the slip in the middle of the mold is poured out, leaving the thicker slip attached to the sides. The thick slip dries into a finished piece of pottery.

Mold shaping can also be done by *jiggering.* Jiggering involves a device called a *jigger,* which consists of two pieces of plaster that form a mold. The potter puts the clay between the two pieces of plaster and, by pressing them together, squeezes the clay into the desired shape.

The wheel method involves the use of a *potter's wheel.* This device consists of a round, flat, metal surface that turns while the potter shapes clay on it.

Most wheels are electrically powered and turn when the potter presses a foot pedal.

As the wheel turns, the potter pushes the thumbs or other fingers into the center of the spinning clay. This action forms the clay into a pot that has low, thick sides. The potter shapes the sides into the desired form by pressing one hand on the inside and one hand on the outside of the spinning pot.

Decorating and glazing. Potters can put simple decorations on their ware by pressing their fingers into the soft clay or by scratching lines into it. Elaborate designs can be drawn on pottery by using colored substances that will not be damaged by heat during firing. Such substances include enamel, glaze, and slip.

One type of pottery decoration is called *sgraffito.* In this method, the potter puts a thin layer of colored substance on a piece of pottery of a different color. The potter then uses a sharp tool to scratch through the colored outer layer, allowing the color of the clay body to form a design in the actual surface of the pottery beneath. Potters can make attractive decorations by filling in the sgraffito grooves with substances of various colors.

Glazing is used not only to decorate, but also to smoothen and waterproof pottery. Potters have developed many types and colors of glaze. They apply it in several ways, including brushing, pouring, or spraying it onto pottery. After a piece of pottery is glazed, the potter fires it. Some types of pottery must be fired before being glazed. After glazing, they are fired again to bake the glaze. A few kinds of pottery are usually not glazed. They include a stoneware called *jasper* and an earthenware called *terra cotta* (see **Terra cotta**).

Firing makes pottery hard and strong. It also makes glaze stick to clay, and it hardens the glaze as well. Pottery is fired in an oven called a *kiln.*

History

Early pottery consisted of simple household utensils. People in several parts of the world were making pottery by about 11,000 B.C. The Egyptians, about 3000 B.C., became the first people to glaze pottery. Pottery making spread from Egypt and the Near East to the areas around the Mediterranean Sea.

By about 1600 B.C., people on the island of Crete were producing beautiful pottery decorated with curved designs and pictures of animals. Cretan methods of making and decorating pottery influenced Greek ware. The ancient Greeks made graceful pottery and decorated it with vivid designs.

Peoples in other parts of the world also developed pottery skills. In North and South America, many Indian tribes developed the art of making pottery. Tribes that created especially beautiful pottery included the Inca, the Maya, and the Pueblo.

In Africa, potters in the kingdom of Nok developed an advanced pottery style by about 500 B.C. They specialized in making decorative pottery in the form of realistic human heads. Between about A.D. 600 and 950, artists in the African kingdoms of Ife and Benin used sculptured pottery figures as models for large, metal statues.

In China, potters had started to use the pottery wheel during the Shang dynasty (c. 1500-1027 B.C.). Chinese potters learned to make porcelain, probably during the Tang dynasty (A.D. 618-907). Potters of the Song dynasty (A.D. 960-1279) experimented with many pottery shapes and glazes. They created some of the loveliest pottery in history.

About 1200, the Chinese began to export pottery to the countries of the Near East. The potters of these nations combined Chinese styles with their own and developed new forms and designs. One of the new forms resulted in a type of colorfully glazed pottery called *majolica* (see **Majolica**).

Pottery of the 1700's and 1800's featured developments in Europe and the New World. The nations of the Near East began to export much of their pottery, including majolica, to Europe. European pottery-making centers, especially in Italy, copied the Near Eastern pottery. The European centers introduced new styles of their own as well, including types of majolica called *delft* and *faïence* (see **Delft; Faïence**).

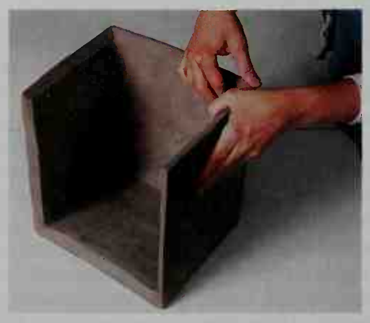
In 1708, Johann Friedrich Böttger, a German chemist,

How pottery is made

First, the potter selects and prepares the clay. The potter shapes it, using one of several methods. Three common methods are described below. After the clay dries, the potter may coat it with a smooth glaze. Finally, the potter bakes the pottery in an oven to harden it.



The coil method involves cutting out a bottom and then rolling ropes of clay and stacking them. The potter then may smooth the layers together.



The slab method. The potter first cuts the clay into slabs and then fastens the slabs to one another with creamy clay called *slip.*

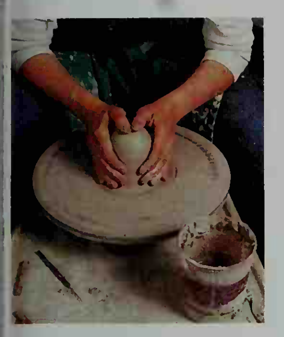


WORLD BOOK photos by Odyssey Productions

The mold method. Slip is poured into a mold. After the slip next to the mold hardens, the extra slip is poured out. The mold is split, and the piece is removed.

Making pottery on a potter's wheel

Since early times, people have made vessels by using a potter's wheel. The wheel consists of a revolving disk mounted on a spindle. The potter spins the disk by using a foot control or mechanical power. Various hand and finger movements are used to mold the clay into the desired shape.



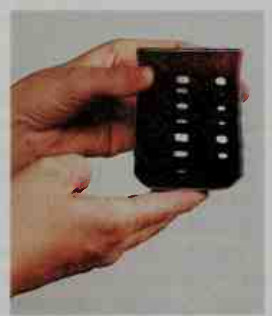
A lump of clay is spun on a wheel. The potter smooths it and pokes both thumbs into the top to make it hollow.



The sides of the vessel are shaped by drawing up the clay. The potter locks thumbs to steady the hands.



Excess clay is trimmed off with a tool. Then the potter removes the finished vessel with a wire or a knife.



WORLD BOOK photos by Odyssey Productions

Finished pottery is given color, smoothness, and extra toughness by being glazed and fired in an oven.

became the first European to discover how to make porcelain. The Chinese had refused to share the secret of porcelain making. After European industrialists established factories to make porcelain, they also kept the method of porcelain making a secret. Many European wares greatly influenced pottery making. These respected wares included Meissen, Sèvres, Wedgwood, and Worcester.

When Europeans settled in the New World, they brought their own styles of pottery making. Later, pottery in the United States followed European styles until 1880. That year, Maria Longworth Nichols, better known by her married name of Mrs. Bellamy Storer, a potter in Cincinnati, Ohio, founded the Rookwood Pottery to produce art pottery. This plant produced pottery that reflected local ideas and tastes. Most of the Rookwood pottery that was produced had colorful glazes and many types of decoration.

Modern styles of pottery developed during the 1900's. These styles resulted from the desire of potters to create individual, personal ware. Today, most studio potters use methods of shaping and decorating that were used before the Industrial Revolution of the 1700's and 1800's. Developments in pottery design that take place in one part of the world quickly reach and influence potters in other regions.

Since the early 1900's, people in many parts of the world have developed an interest in pottery making as a hobby. Amateur potters can go to specialized schools and pottery studios to learn the craft. Exhibitions encourage amateur and professional potters to show their wares and to exchange ideas. William C. Gates, Jr.

Related articles in *World Book* include:

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China (Sculpture and pottery; pictures)
Clay
Enamel
England (picture: Hand painted Spode china)
Geometric style
Indian, American (Arts and crafts)
Ming dynasty (with picture)
Porcelain
Prehistoric people (The end of prehistoric times)
Tang dynasty (picture)
Tile
Wedgwood ware

Additional resources

Camusso, Lorenzo, and Bortone, Sandro, eds. *Ceramics of the World: From 4000 B.C. to the Present.* Abrams, 1992.
Speight, Charlotte F., and Toki, John. *Make It in Clay.* Mayfield Pub. Co., 1997.

Potto is a small animal that lives in western Africa. The potto belongs to the order of animals that includes monkeys, apes, and human beings. However, the potto looks more like a sloth than a monkey or ape. The potto is a member of a group of animals that is called *slow lemurs* or *lorises.*

The potto has a short tail, and the tips of several neck *vertebrae* (spine bones) project through the skin. The animal may use this partially exposed backbone as a defense. The potto is a slow-moving animal that spends its time in trees. It can grip branches firmly because its



Jen and Des Bartlett, Bruce Coleman, Ltd.

The potto lives in the forests of western Africa. It usually sleeps during the day in hollow trees and hunts for food at night. The potto's big protruding eyes help it see easily in the dark.

thumb faces the other fingers. The potto's index finger is a mere stub and has no nails or joints. Pottos live alone or in pairs, and are most active at night. They eat bats, birds, insects, fruits, and eggs. Clyde Jones

Scientific classification. Pottos belong to the loris family, Lorisidae, and make up the genus *Perodicticus.* The only species is *P. potto.*

Pouched mammal. See Marsupial.

Poulenc, *poo LANK,* **Francis,** *frahn SEES* (1899-1963), was a French composer and pianist. He was particularly noted for his vocal music, which features beautiful melodies and great sensitivity to words. Poulenc's songs and song cycles are among the most important solo vocal works of the 1900's.

Poulenc, a devout Roman Catholic, wrote several major religious works, including his *Mass in G* (1937), *Stabat Mater* (1950), and *Gloria* (1959). He also wrote the religious opera *The Dialogues of the Carmelites* (1957) and a one-act tragedy for soprano, *The Human Voice* (1959). Poulenc was a fine pianist and developed a highly personal composing style in such works as *Trois mouvements perpétuels* (1918).

Poulenc was born in Paris. In the early 1920's, he became a member of a group of six French composers known as *Les Six.* Daniel T. Politoske

Poulsen, Valdemar. See Tape recorder (History).

Poultry are birds that are raised to provide meat and eggs for human food. Chickens are by far the most common kind of poultry raised throughout the world. Other important species include turkeys, ducks, geese, guinea fowl, pheasants, pigeons, and quail. Some birds are particularly prized by certain peoples. For example, guinea fowl are an important species in France.

Although poultry are used primarily for food, they also provide several important by-products. Manufacturers use the feathers of ducks and geese to stuff pillows and insulated clothing. Farmers use poultry manure as fertilizer. Eggs are used not only as food but also in making paint, vaccines, and other products.

Chickens, ducks, and turkeys are the most common kinds of poultry raised in the United States and Canada. In the late 1990's, U.S. farmers earned about $22 billion a year from the sale of poultry meat and eggs. Canadian farmers earned about $1.4 billion (in U.S. dollars) annually from poultry and eggs.

People in the United States consume an average of 65 pounds (29 kilograms) of poultry yearly. About 80 percent of the poultry consumed comes from chickens. The rest comes mainly from turkeys. Canadians eat an average of 61 pounds (28 kilograms) of poultry a year. People in the United States eat an average of about 240 eggs each per year. Canadians average 235 eggs annually. Almost all the eggs eaten in Canada and the United States are chicken eggs. People in some other countries also eat the eggs of ducks, geese, and other fowl.

California, Indiana, Iowa, Ohio, and Pennsylvania lead the United States in egg production. Leading producers of chickens for use as meat include Alabama, Arkansas, and Georgia. Minnesota and North Carolina are the chief turkey-producing states. Other leading producers include Arkansas, California, Missouri, and Virginia. Long Island produces about a fourth of the ducks in the United States. Ontario and Quebec produce the majority of the poultry products in Canada.



A large poultry house holds thousands of chickens. Mechanical equipment brings feed and water to the birds automatically.

Raising poultry. Most of the poultry produced in the United States comes from large commercial farms that raise only these birds. Some of the farms have flocks of more than a million birds. A small percentage of U.S. poultry is raised in flocks that consist of 5,000 or fewer birds. Many small poultry farmers also do other kinds of farming. Most commercial poultry farmers buy baby birds from hatcheries, which hatch eggs in incubators.

Female chickens raised to produce eggs are called *laying hens.* They begin to lay eggs when they are about 21 weeks old. The birds are kept in long, low buildings called *laying houses,* each of which may hold as many as 50,000 hens. In many of these houses, the hens live in cages that have a sloped floor so the eggs can roll out. In highly automated laying houses, mechanical devices carry feed and water to the hens, and a conveyor belt carries the eggs to a central collecting room. The hens are kept in the laying house for about 12 months after they start to lay eggs. Then they are either kept in laying houses for another season, or are sold for slaughter and replaced with young birds.

Chickens raised only for their meat are called *broilers* or *fryers.* Most broilers are raised indoors on a dirt or concrete floor that is covered with *litter.* Litter is straw, wood shavings, or some other material that absorbs moisture, keeping the birds clean. Broilers eat and drink from automatic feeders and water containers.

Geese, turkeys, and some other birds require more space because they are larger than chickens. Most of these birds are raised outdoors in pens or fenced fields. However, many turkey farmers raise their birds indoors. Most ducks are also raised indoors. Pheasants, quail, and other birds are cared for much as broilers are, but most farmers raise them in smaller flocks.

Poultry feed consists of a mixture of ingredients that promotes rapid growth or high egg production. The main ingredient is corn, wheat, sorghum, or some other

grain. The grain is mixed with protein supplements, such as soybean meal or meat by-products. Vitamins and minerals are also added. A broiler eats an average of 1 pound (0.45 kilogram) of feed per week. A laying hen consumes about 4 pounds (1.8 kilograms) of feed for every dozen eggs that she lays.

Diseases and parasites are a major problem of poultry farmers. Many birds are kept in a small area, and so disease can spread quickly through a flock. Farmers vaccinate their birds, add drugs to the water or feed, and keep the flocks clean. Respiratory ailments of poultry include *Newcastle disease, infectious bronchitis,* and *laryngotracheitis. Marek's disease* and *leukosis,* which kill many birds, result from tumors caused by viruses. Parasites cause a disease called *coccidiosis.*

Breeding is another important aspect of poultry raising. Breeders have developed types of birds that produce more meat or eggs than other types. For example, turkeys raised in the United States have an extremely broad breast that yields much white meat.

Marketing poultry and eggs. Poultry raised for meat are marketed at various weights and ages. For example, broilers reach a market weight of about 4 pounds (1.8 kilograms) when they are about 8 weeks old. Turkey market weights vary widely, depending on type. A typical hen turkey reaches its market weight of about 15 pounds (6.8 kilograms) at 15 weeks old. Tom turkeys weigh about 24 pounds (11 kilograms) at 17 weeks. Ducks are ready for market when they are 7 or 8 weeks old and weigh approximately 6 pounds (2.7 kilograms).

Market-size poultry are sent to processing plants to be slaughtered, inspected, and graded. Then they are sent to supermarkets. More than 90 percent of the broilers sold in the United States and Canada are sold fresh. About 70 percent of the turkeys are processed and sold as specialty meat. Most whole turkeys are sold frozen, chiefly at Thanksgiving and Christmas. About 40 percent of ducks and geese are sold frozen.

Egg farmers generally sell their eggs directly to supermarkets or to wholesalers. Most eggs are sold to consumers fresh, though some are used in such processed food items as cake mixes and noodles. Eggs must be washed, graded, and packed in cartons to prepare them for marketing. Inspectors determine the quality of the interior of an egg by *candling.* This technique involves examination of the egg while shining a strong light through it from behind. Eggs are stored and shipped under refrigeration to ensure their freshness.

During the 1970's, the poultry industry developed several new kinds of processed meats from poultry. These meats included "frankfurters" made of chicken and "ham" made of smoked turkey. The poultry meats were generally cheaper and less fatty than the products made from beef or pork. N. Paul Johnston

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Feather	Nutrition	Quail
Goose	Ostrich	Turkey
Grouse		

Pound, also called *pound sterling,* is the monetary unit of the United Kingdom and some other countries. The British pound (£) is equal to 100 pence (*p*). There are paper bills for £5, £10, £20, and £50. In 1983, the British government introduced a one-pound coin to replace the one-pound note, which it stopped issuing on Dec. 31, 1984. In 1999, the government began issuing a five-pound coin.




WORLD BOOK photo

A British one-pound coin has a picture of Queen Elizabeth II on the front and a symbol of the United Kingdom on the back.

Until 1931, the government had made for circulation one-pound gold coins called *sovereigns.* Sovereigns were first made in 1489. Later, the sovereign was called a *unite,* in honor of the joining of England and Scotland under James I, who became king of both nations in 1603. George III chose the sovereign as the monetary unit, and it was first issued regularly in 1817. Half sovereign, two-pound, and five-pound pieces were also coined. Sovereigns and other gold coins are now used for dealings with nations that require payment in gold.

The British pound is often used as an international form of money to settle debts between nations. But gold and United States dollars are the most widely accepted forms of international money. Burton H. Hobson

Pound is a unit of weight used primarily in the United States. In science and technology, *weight* refers to the gravitational force on an object, and the pound is used as a unit of force. This unit also appears in the term *pounds per square inch* (psi), which is used as a measure of pressure. In commercial and everyday use, the term *weight* is understood to mean *mass* (quantity of matter), and so the pound is also used as a unit of mass.

In the system of weights called the *avoirdupois (AV uhr duh POYZ) system,* which is used to weigh most objects, there are 16 ounces to a pound. As a unit of force, the avoirdupois pound is equivalent to 4.448 newtons in the metric system; as a unit of mass, 0.454 kilogram in the metric system. In the troy weight system, used throughout the world to measure precious metals, a pound equals 12 ounces and is equivalent to 0.373 kilogram.

The abbreviation for pound is *lb.* The abbreviation stands for the Latin word *libra,* which means *pound* or *balance.* Libra was the name of a unit of weight used by the ancient Romans, and it was the name for a balance, or scale, that Romans used to measure weight. The symbol # is sometimes used for pound. Michael Dine

See also **Avoirdupois; Metric system; Troy weight; Weight; Weights and measures.**

Pound, Ezra Loomis (1885-1972), was an American poet and essayist. He became one of the most influential and controversial literary figures of the 1900's.

Disillusioned with what he considered the artistic backwardness of the United States, Pound left the country in 1908. He lived in Venice, London, Paris, and, finally, Rapallo, Italy. He became the friend and critic of Irish writers William Butler Yeats and James Joyce.

Pound also helped such then-unknown poets as T. S. Eliot, William Carlos Williams, and Robert Frost.

Pound's early work reflects his conviction that the poet must play a vital role in the culture of the time. In his poem "Hugh Selwyn Mauberley" (1920), Pound revealed his anger at the slaughter during World War I (1914-1918) and his despairing sense of the failure of art to affect the course of history.

Pound spent the last 50 years of his life composing a never-completed, 800-page poem called *The Cantos.* In the first section, Pound traced the rise and fall of Western and Eastern civilizations, emphasizing the conflict between artistic spirit and materialistic greed. The *Cantos* that were written during the late 1920's and the 1930's deal with the economic and political corruption Pound saw developing since the time of two of his heroes, John Adams and Thomas Jefferson.

Pound's indignation rapidly turned to anti-Americanism and anti-Semitism. Pound became an admirer of the Fascist rule of Italian dictator Benito Mussolini. During World War II (1939-1945), Pound broadcast Fascist propaganda to the United States. In 1945, the U.S. government arrested Pound for treason. While imprisoned at a U.S. Army camp in Pisa, Italy, Pound wrote some of his most moving and self-critical verses, the *Pisan Cantos.* In 1946, Pound was judged insane and spent 12 years in a Washington, D.C., mental hospital. He was released in 1958 and returned to Italy.

Pound was born in Hailey, Idaho. An edition of *The Cantos* was published in 1970. His criticism was collected in *Literary Essays of Ezra Pound* (1954) and *Selected Prose 1909-1965* (1973). Steven Gould Axelrod

See also **American literature** (Modernist poetry).

Pound, Roscoe (1870-1964), was an American educator and authority on law. He introduced to the United States a view of the nature and purpose of law which came to be known as "sociological jurisprudence." This view treats law as a system of social engineering.

Pound wrote widely on legal history, legal philosophy, and law reform. He became one of the best-known figures in American legal education. His books include *The Spirit of the Common Law* (1921), *Law and Morals* (1924), *The Formative Era of American Law* (1938), and *Social Control Through Law* (1942). Pound was born in Lincoln, Nebraska, and graduated from Harvard Law School. He became a professor of law at Harvard in 1910, and served as dean of the Harvard Law School from 1916 to 1936. David M. O'Brien

Pound sterling. See **Pound** (money).

Poundmaker (1826-1886), a Cree Indian chief, led a band of warriors against the Canadian government during the North West Rebellion in 1885 (see **North West Rebellion**). The Cree had been suffering from shortages of food. They joined the uprising because they felt the government had done little to help them solve this and other problems.


The Public Archives of Canada
Poundmaker

In March 1885, Poundmaker's band raided Battleford, in what is now Saskatchewan. In May, Indians led by Poundmaker defeated Canadian troops in the Battle of Cut Knife Hill. The Cree chief later surrendered after learning that the forces of Louis Riel, the leader of the rebellion, had been defeated. Poundmaker was sentenced to three years in prison. He served only six months and died shortly after his release. He was born near what is now Edmonton, Alta. His Indian name was Opeteca-hanawaywin.

Hartwell Bowsfield

Poussin, *poo SAN,* **Nicolas,** *nee kaw LAH* (1594-1665), was the most highly respected French painter of his age. Poussin believed that painting should appeal to the mind more than to the senses. His works are meant to be read from figure to figure and incident to incident, and to be brought together as a whole in the viewer's mind. He believed an artist should choose as subjects only the noblest human actions, and he took almost all his subjects from mythology and from the Bible.


Saint Matthew and the Angel (about 1643), an oil painting on canvas; Staatliche Museum, Berlin

A Poussin painting shows the harmony and clarity typical of the artist's classical style. The figures of Saint Matthew and an angel reflect Poussin's interest in religious themes.

Like many painters of the mid-1600's, Poussin believed that drawing was a more important foundation of painting than color. The clarity of Poussin's forms reflects this belief. However, for all of Poussin's sober forms and clarity of color, his paintings, especially his religious works, show deeply felt emotion.

Poussin was born in or near Les Andelys, near Rouen. He went to Paris at the age of 18 to become a painter, but he did not develop his own style and gain success until he traveled to Italy 12 years later. He lived in Rome nearly all of the rest of his life. He was supported by aristocratic patrons, and he held the position of First Painter to the king of France. Ann Friedman

For examples of Poussin's work, see **Painting** (The 1600's and 1700's) and **Mythology** (How myths began). See also **Classicism** (The qualities of classicism).

Poutrincourt, *poo tran KOOR,* **Jean de Biencourt de** (1557-1615), Baron de St. Just, a French colonizer, helped found Acadia, a region in eastern Canada and northern Maine (see **Acadia**). He went to Canada in 1604 with Sieur de Monts (see **Monts, Sieur de**). Poutrincourt received a grant of land and established a colony at Port

Royal. In 1606, he accompanied Samuel de Champlain in his exploration of the Bay of Fundy. In 1607, Poutrincourt went back to France. He returned to Acadia in 1610 and lived at Port Royal until 1613, when English settlers from Virginia destroyed most of the settlement. He then went back to France. His son Charles de Biencourt de Saint-Just stayed in the colony and traded with the Indians. Poutrincourt was born in Picardy, France.

John A. Dickinson

Poverty is the lack of enough income and resources to live adequately by community standards. These standards—and the definition of poverty—vary according to place and time. For example, many people who live in the United States today believe they must have an automobile to live decently. Such people would consider themselves poor if they could not afford one. However, people who live in some nonindustrial countries regard cars as luxuries. They would not consider the lack of a car a sign of poverty.

Poverty causes suffering among millions of people. Many of the poor cannot buy the food, shelter, clothing, and medical care that they need. Neediness causes malnutrition and poor health. It also produces feelings of frustration, hopelessness, and a loss of dignity and self-respect. Governments and private organizations have tried to reduce or eliminate poverty. But it remains a widespread and serious world problem.

Who are the poor?

The different definitions of poverty from country to country make it difficult to determine how many people are poor. It is estimated that more than 1 billion people, about a fifth of the world's population, are so poor that their health and lives are endangered. The most widespread and severe poverty occurs in nations with few resources. These nations are sometimes called *developing nations.* This article will deal mainly with poverty in the United States and other highly industrialized nations. For information on poverty in other countries, see **Developing country.**

Measuring poverty. The U.S. government measures poverty according to yearly income. The government identifies as poor those households whose incomes fall at or below a certain level called the *poverty level* or *poverty line.* The poverty line is based on the income that households need to eat adequately without spending more than a third of their income on food. The U.S. government revises the poverty line each year to keep up with changes in the cost of living.

The government varies the poverty line according to household size. In addition, it varies the poverty line for one- and two-person households of people 65 and older. For the poverty line for families of various sizes, see the table "Poverty in the United States" that appears in this article.

The distribution and rate of U.S. poverty. The U.S. government classifies approximately 14 percent of the population as poor. Some groups have poverty rates that exceed that of the general population. These groups include African Americans, Hispanic Americans, and families headed by single mothers. Groups with lower-than-average poverty rates include the elderly and two-parent families.

Many people are poor at some time in their lives. Most can raise their incomes above the poverty line within a few years. But many of the people who are poor are in the midst of a long period of poverty lasting a decade or more. Many poor people are homeless.

The poverty rate has gone alternately up and down in the United States since the 1960's. The rate tends to fall in times of strong economic growth and rise when the economy is weak. A number of other factors have put upward pressure on the poverty rate. They include a rise in the percentage of the population that lives in single-parent families. Such families have a much higher poverty rate than two-parent families. Also, some government social welfare programs have reduced the amount of assistance to the poor. In addition, the wages of many workers do not always rise as fast as prices.

Because the United States is such a prosperous country, a smaller percentage of its citizens lack basic necessities than the citizens of many other countries. But the poverty rate is higher in the United States than in several other industrialized nations, including Canada, Australia, and Germany. Such nations often have more generous social programs for the poor.

Effects of poverty

Effects on the poor. Poverty-stricken people suffer from the lack of many things they need. For example, they are less likely to receive adequate medical care or to eat the foods they need to stay healthy. The poor have more diseases, become more seriously ill, and die at a younger age than other people do. Poor people often live in substandard housing in socially isolated areas where most of their neighbors are poor. Many low-income families live in crowded, run-down buildings with inadequate heat and plumbing. The jobs most readily available to the poor provide low wages and little opportunity for advancement. Many of these jobs also involve dangerous or unhealthful working conditions. Financial, medical, and emotional problems often strain family ties among the poverty-stricken.

The poor have less economic and political influence than other people have. For example, businesses try to produce goods and services that many people will buy. Low-income consumers buy relatively little, and so they have relatively little influence on what businesses produce. The needy have little political power because few of them vote in elections.

Some social scientists call poverty a vicious circle or say that poverty breeds poverty. Studies show that some children born into low-income families remain poor for many years. Poor children often enter school with less preparation and less-developed language skills than other children do. They also often attend lower-quality schools and thus are less likely to go to college or get a good job. Public schools in the United States rely heavily on local property taxes. Low-income communities generate less tax money, and so they cannot afford the educational programs that wealthier communities have.

Some social scientists say the poor have a set of customs, values, and attitudes that are part of a *culture of poverty.* This culture tends to view educational and economic achievements as a product mostly of luck rather than hard work. Many social scientists consider this culture a result of the economic stresses that are associated with poverty. However, some social scientists believe

Poverty in the United States

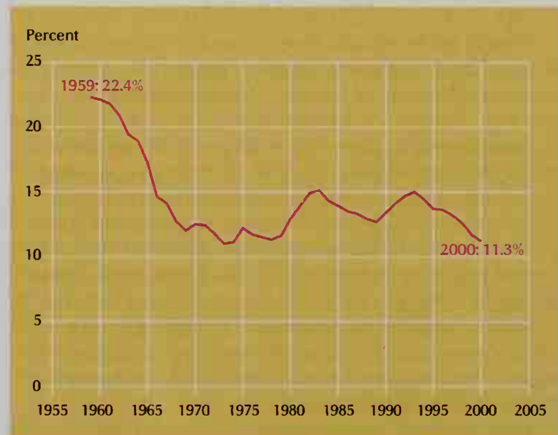
This table shows the average poverty line for families of various sizes in 2000. For example, the government classified an average family of four persons as poor if its annual income was $17,603 or less. This table also shows the number of families at or below the poverty line for each level of family size.

Family size	Annual income	Number of families
1	$ 8,794*	8,529,000
2	11,239*	2,202,000
3	13,738	1,428,000
4	17,603	1,250,000
5	20,819	708,000
6	23,528	342,000
7	26,753	135,000
8	29,701	75,000
9 or more	35,060	81,000

*For persons 65 and older, the poverty line was $8,259 for a single person and $11,590 for a two-person family.
Source: U.S. Census Bureau.

Poverty rate in the United States since 1959

The poverty rate is the percentage of people living at or below the poverty line. The Census Bureau began measuring the poverty rate in 1959.



Source: U.S. Census Bureau.

the culture also causes poverty. Both views are widely held by the public and lawmakers, which has caused disagreements over which policies are the best for reducing poverty.

Effects on society. Society is affected by poverty in a number of ways. For example, inadequate food, medical care, and education reduce the economic and social contributions of the poor. A person who is ill or poorly educated is less likely to become a productive worker or an active citizen. A significant portion of the revenue that state and federal governments collect through taxes pays for programs that assist the needy.

Poverty is also associated with crime. Urban slums, inhabited mainly by poor people, have high rates of violent crime and drug abuse. However, many of the needy do not commit crimes, and numerous nonpoor people do. As a result, many social scientists disagree about the extent to which poverty causes crime.

The causes of poverty

Poverty in the United States has a variety of causes. One major cause is that steady, well-paying jobs can be difficult to find and keep. Many people lack the education or skills needed for such jobs. Other people are too old or sick to work.

Economic forces and changes in labor requirements also cause poverty. For example, inflation contributes to poverty by reducing the amount of goods that a given amount of money can buy. People whose incomes fail to keep pace with prices can afford less and less. Economic downturns add to poverty by forcing businesses to lay off workers. Advances in technology may cause unemployment and poverty among workers whose jobs are taken over by machines. Poverty also may strike a particular community when a major business moves away or closes, leaving workers jobless.

Social forces also contribute to poverty. For example, certain employers purposely try to avoid hiring blacks and other members of minority groups. Other employers pay such people less than similarly qualified workers who are not members of minority groups. Laws prohibit such unequal treatment in the United States, but it persists and adds to neediness among minorities.

Many women become poor after they have become widowed, divorced, or separated from their husbands. Some of them lack the education, job experience, and skills they need to support themselves and their children. Many women also have difficulty obtaining the child-care services they need to work outside the home. In addition, many employers pay women less than similarly qualified men, though such policies are illegal.

The fight against poverty

Many Americans believe the United States has enough resources to eliminate poverty. However, Americans disagree about the best way to accomplish this task. The federal government—along with the state governments—fights poverty with three major weapons: (1) measures to improve job opportunities, (2) educational programs, and (3) social welfare programs.



© Owen Franken, Stock, Boston

Victims of poverty often suffer from poor nutrition, inadequate medical care, and emotional anxiety. As a result, many of them cannot become productive workers or active citizens.

Measures to improve job opportunities include efforts to reduce unemployment. For example, the government tries to promote economic growth and stability, which keep the demand for workers high. Under the federal Job Training Partnership Act, state and local governments receive federal funds to provide job training for unskilled, disadvantaged youths and for needy adults. The Job Corps furnishes job training for unemployed people between the ages of 16 and 22. The Equal Employment Opportunity Commission seeks to promote equal job opportunities for women and minority group members.

State and federal minimum-wage laws establish the lowest hourly wage employers can pay. But some people argue that minimum-wage laws contribute to unemployment. They say some companies cannot afford to pay workers the minimum wage. Laws that force these firms to raise their wages may force them to close or to employ fewer workers, increasing unemployment.

Educational programs are designed to give the poor the knowledge and skills they need to support themselves. Such programs serve people of all ages. The Head Start program offers educational, medical, and social benefits to preschool children from low-income families. School integration and bilingual education attempt to improve the education of members of minority groups. Scholarships, loans, and work-study programs help many needy students attend college. Adult Basic Education trains adults in such skills as reading and arithmetic. Educational programs, such as programs that improve job opportunities, receive wide support. However, they cannot help all the poor.

Social welfare programs provide money, food, medical care, and other aid to the poor and certain other groups. The government provides two main types of aid: *social insurance* and *public assistance*. Social insurance mainly covers people—or their families—who have worked and paid special taxes in the past, whether or not they are poor. Public assistance provides aid to the needy regardless of their work record.

Social-insurance programs include (1) Social Security, (2) unemployment insurance, and (3) workers' compensation. Social Security pays benefits to retired or disabled workers and their dependents. It also provides financial aid to the families of workers who have died. Social Security includes a health insurance program called *Medicare*. Medicare helps the aged and the disabled pay medical costs. Unemployment insurance pays workers who have lost jobs. Workers' compensation gives cash and medical care to workers who have been hurt on the job and cannot work as they could before.

Public-assistance programs, also called welfare programs, include (1) cash aid for the poor, (2) food stamps and other nutrition programs, (3) Medicaid, (4) Supplemental Security Income, (5) housing programs, and (6) day-care programs. Cash aid programs provide money to poor people who cannot support themselves or their dependents. Food stamps, which are available to low-income families, can be exchanged for certain kinds of groceries. Medicaid pays medical expenses for many people who otherwise cannot afford them. Supplemental Security Income guarantees a minimum income to the aged and to the blind and others who are disabled. Housing programs include the construction of public housing for the poor and financial aid, which is used to help needy people pay their rent. Day-care services for children enable low-income parents to hold jobs or to get training outside the home. Sheldon H. Danziger

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Medicare
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Old age (Finances)
Social security
Unemployment
Unemployment insurance
Welfare

Additional resources

Danziger, Sheldon H., and others, eds. *Confronting Poverty: Prescriptions for Change*. Harvard Univ. Pr., 1994.
De Koster, Katie, and Leone, Bruno, eds. *Poverty: Opposing Viewpoints*. Greenhaven, 1994.

Powder. See Cosmetics; Gunpowder.

Powder horn was a container for carrying the gunpowder used in muzzleloading firearms. People usually used cattle horns for powder horns. The hollow horn was cut at both ends and then scraped on the inside. Caps constructed of metal or wood were attached to the ends to hold the powder in. To load a gun, the cap on the small end of the horn was removed, and the powder was poured into a measure for the correct charge. People often decorated powder horns, and they usually wore the horns slung over the shoulder.

Douglas M. Wicklund

Powder metallurgy is a process that reduces metals to powdered form and presses the powder into certain somewhat restricted shapes. A heating process called *sintering* is used to bind the metal powders and add strength to the finished product.

Powder metallurgy has many advantages over other methods of making metal objects. Some metals will not mix (alloy) when heated to the *fusion* (melting) point. But these metals can be made to form valuable compounds by powdering them and then mixing the powders together. For example, graphite will not fuse with metals by heat alone. But it can be powdered and mixed with powdered metals, pressed into shape, and heated to make a bearing. Such a bearing does not need frequent oiling because the graphite acts as a self-lubricant. Other advantages of powder metallurgy include rapid production, high dimensional accuracy, controlled *porosity* (number, shape, and size of pores), low scrap loss, and use of unskilled labor.

Metals are made into powders in many ways. Molten metals can be *atomized* (broken down into tiny drops), and some solid metals can be crushed. Another method is electrolysis (see **Electrolysis**). A fourth way is to heat the oxide compound of the metal in contact with hydrogen. Joel S. Hirschhorn

Powell, Adam Clayton, Jr. (1908-1972), was a political and religious leader of New York City's Harlem area. From 1945 to 1955, he and William Dawson of Chicago were the only African Americans in the United States Congress. Powell condemned all forms of segregation and discrimination, especially in his early years in Congress. Later, his absenteeism, boastful attitude, and colorful private life disappointed many reformers and offended many members of Congress. But he remained popular in his congressional district.

Powell became pastor of the Abyssinian Baptist

Church in Harlem in 1937. He was first elected to the U.S. House of Representatives in 1944. In 1960, he became chairman of the House Committee on Education and Labor. Powell was denied his seat in Congress by the House in 1967 on grounds he misused public funds. He won a special election to fill the vacancy, but he did not claim his seat. He won the regular election in 1968 and returned to Congress in January 1969. In 1969, the Supreme Court of the United States ruled that Congress had acted unconstitutionally when it excluded Powell in 1967. In 1970, he was defeated in his bid for renomination in the Democratic primary.


Wide World
Adam Clayton Powell, Jr.

Powell was born on Nov. 29, 1908, in New Haven, Connecticut. He graduated from Colgate University and received graduate degrees from Columbia and Shaw universities. Richard Bardolph

Powell, *POH uhl,* **Anthony** (1905-2000), an English writer, became best known for his 12-volume series of novels called *A Dance to the Music of Time.* In the series, Powell described what he considered the changing nature of the English upper-middle class from the early 1920's to the 1970's. The novels are narrated by Nicholas Jenkins, who speaks for Powell. Jenkins records his experiences and those of a group of characters, especially Widmerpool, a ruthless, aggressive, self-made man. The series began with *A Question of Upbringing* (1951) and concluded with *Hearing Secret Harmonies* (1975).

Powell was born on Dec. 21, 1905, in London. He began his literary career with the comic satiric novels *Afternoon Men* (1931), *Venusberg* (1932), *From a View to a Death* (1933), and *Agents and Patients* (1936). Powell also wrote *John Aubrey and His Friends* (1948), a biography of English author John Aubrey. His plays include *The Garden God* (1971) and *The Rest I'll Whistle* (1971). Powell wrote four volumes of autobiography (1976-1982) under the title *To Keep the Ball Rolling.* Garrett Stewart

Powell, Colin Luther (1937-), became the first African American secretary of state of the United States in 2001. President George W. Bush appointed Powell, a former U.S. Army general, to the post.

Powell was born on April 5, 1937, in New York City. His parents were Jamaican immigrants. He graduated from the City College of New York and earned an M.B.A. degree from George Washington University. He was commissioned a second lieutenant in the Army in 1958. He served in Vietnam in 1968 and 1969. He later headed forces in South Korea, West Germany, and the United States. In 1986, he became commanding general of the Fifth Corps in Germany. In 1987, President Ronald Reagan named him assistant to the president for national security affairs. In 1989, President George H. W. Bush appointed Powell chairman of the Joint Chiefs of Staff, the nation's highest military advisory group.


Reuters/Archive Photos
Colin Luther Powell

In 1991, Powell won the Spingarn Medal for his achievements. In 1993, he retired as Joint Chiefs of Staff chairman and from the Army. He wrote *My American Journey* (1995), an autobiography. In 1997, President Bill Clinton appointed him chairman of a campaign directed toward helping children develop learning and work skills. Joel D. Meyerson

Powell, John Wesley (1834-1902), was an American explorer, geologist, and biologist. He is known as an explorer of the Colorado River, an expert on the arid lands of the West, and an early environmentalist.

Powell was born on March 24, 1834, in Mount Morris, New York. He attended several colleges but never earned a degree and was largely self-taught. Powell served in the Union Army during the American Civil War (1861-1865). He lost his lower right arm in the Battle of Shiloh in 1862. From 1865 to 1867, he was a professor of natural science at Illinois Wesleyan University.

In 1868, Powell explored the Green and Colorado rivers in what are now Colorado and Utah. A year later, he led the first expedition of white men to travel in boats down the Colorado through the Grand Canyon in what is now Arizona. During his journeys, Powell recorded his observations of the terrain and the plant and animal life. He also studied the cultures of the Indian tribes he encountered along the way.

In 1879, Powell became director of the Bureau of Ethnology, devoted to studying American Indians. He held the office until his death on Sept. 23, 1902. From 1881 to 1894, he had also served as director of the United States Geological Survey. Helen Delpar

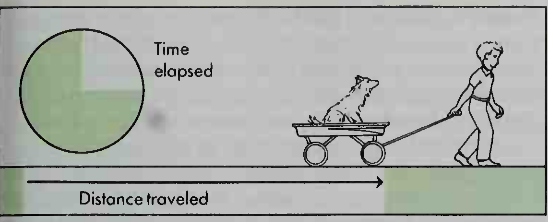
Powell, Lewis Franklin, Jr. (1907-1998), was an associate justice of the Supreme Court of the United States from 1972 to 1987. President Richard M. Nixon nominated him to fill the vacancy created when Justice Hugo L. Black retired.

Powell was born on Sept. 19, 1907, in Suffolk, Virginia. He attended Washington and Lee University and graduated from the university's law school in 1931. He earned a master's degree from the Harvard Law School the next year. From 1932 to 1972, Powell practiced law in Richmond, Virginia, and was regarded as one of the state's most distinguished lawyers. Powell served as president of the American Bar Association in 1964 and 1965. In that position, he proposed various improvements in court procedures and in legal aid to the poor.

On the Supreme Court, Powell generally held conservative views, especially in cases involving criminal justice. For example, he supported state laws imposing the death penalty. However, he often provided the decisive "swing vote" in the court's 5-4 decisions. In 1986, he cast the deciding vote in two major court rulings viewed as victories for liberals. One of these decisions supported affirmative-action programs, and the other reaffirmed the court's 1973 ruling establishing a woman's right to have an abortion. Owen M. Fiss

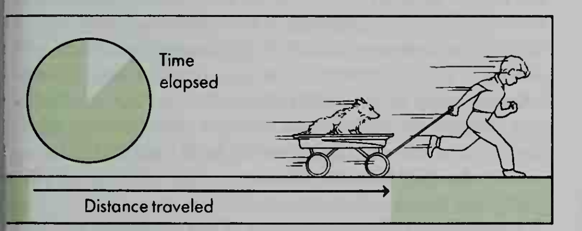
See also **Supreme Court of the United States.**

Power, in physics, is the rate of doing work. Physicists consider that work is done whenever a force moves an



WORLD BOOK diagrams by Leon Bishop

The power needed to pull a wagon depends on its weight, and how far and how fast it is pulled. A boy uses a certain amount of power to pull a dog in a wagon over a given distance in a set time, *above.* He must use twice as much power to pull the dog and wagon over the distance in half the time, *below.*



object against a resistance. The amount of work done depends on the size of the force and on the distance that the object moves in the direction of the force. The idea of power involves time, as well as force and distance. The power exerted determines the amount of work that can be accomplished per unit of time.

A task requires the same amount of work whether done quickly or slowly. But greater power is necessary to do the work quickly. For example, a horse does the same amount of work if it pulls a load over a given distance in 20 seconds or in 10 seconds. But it must use twice as much power to perform the task in the shorter time.

Power can be calculated with the following formula:

$$P = \frac{W}{t}$$

In the formula, P stands for power, W for work, and t for time. Physicists measure work by multiplying the force times the distance. Therefore, the formula for power can also be written:

$$P = \frac{Fd}{t}$$

Here F stands for force and d for distance.

In systems of measurement, power is always expressed as units of work divided by units of time. The basic unit of power in the customary, or English, system is *foot-pounds per second.* One foot-pound of work is done when a force of 1 pound moves an object 1 foot. For example, if a 100-pound object is lifted 2 feet, the work done equals 200 foot-pounds. If the work is performed in 4 seconds, the power used is 50 foot-pounds per second:

$$P = \frac{100 \text{ pounds} \times 2 \text{ feet}}{4 \text{ seconds}} = \frac{50 \text{ foot-pounds}}{1 \text{ second}}$$

Another unit of power in the customary system, the *horsepower,* equals 550 foot-pounds of work per second. The horsepower originally represented the amount of power delivered by a typical draft horse.

In the metric system, the common unit of power is the *watt.* A watt is the power needed to perform one *joule* of work per second. A joule of work is done when 1 *newton* of force moves an object 1 meter (see Newton). One horsepower equals 746 watts.

Gregory Benford

Related articles in *World Book* include:

Energy	Horsepower	Watt
Foot-pound	Joule	Work
Force		

Power, in the social sciences, is the ability of persons or groups to impose their will on others. Persons with power can enforce their decisions by applying, or threatening to apply, penalties against those who disobey their orders or demands. Power is present in almost all human relationships. Teachers have power over students, employers over employees, parents over children, bullies over weaklings, and militarily strong nations over weak nations.

Forms of power include *coercion, influence,* and *authority.* Coercion is the use of physical force to enforce decisions. Influence is the ability to produce an effect through example, persuasion, or some other means without using force.

Authority is power that is based on agreement by a majority of the members of a society or group. For example, teachers have power (authority) over their students because it is widely recognized and agreed that they must have it to keep order and teach effectively. In democracies, the authority of government is based on the consent of the governed. Leaders chosen by the voters in free elections have authority to make decisions for the people.

Main sources of power include (1) superior resources, (2) superior numbers, and (3) superior organization.

Resources may be physical or human. Physical resources include money, goods, and property. They give a person the power to buy what he wants, and enable him to command the services of others. Human resources that give power include intelligence, knowledge, skill, prestige, social position, bravery, and personal charm or beauty. Such qualities become a source of power when they enable a person to lead, influence, or control other persons.

Power in numbers can be seen in elections which give the winners the authority to make decisions for the group. But numbers are not all-important. Inferior numbers can exercise power when they have control of important resources, such as the military.

Superior numbers and resources do not by themselves give a person a high degree of power over others. People must know how to use their resources effectively. They do this through organization. Individuals alone have relatively little power to affect important decisions. But by joining together in some kind of organization, they can become powerful. Political parties, pressure groups, and other associations attempt to gain power through social organization. Countries also join together to consolidate power. International power groups include the European Economic Community (EEC) and the Organization of American States (OAS).

Systems of power. Power relationships occur in all societies and organized groups. There are important differences in how private and public power systems en-

force their decisions. The leaders of private groups—such as businesses and clubs—can fine, suspend, and even expel dissenting members. But only public power systems—that is, governments—can legally use physical force, including imprisonment. Governments control the police and the military, the chief agents of force. This monopoly of force makes control of the state an important source of power.

The social organization that enables certain people to govern in all the organized groups of a community or society makes up the *power structure.* Sometimes, the most powerful people are referred to as *the Establishment,* or the *power elite.* Wolf Heydebrand

See also **Government.**

Power, in arithmetic, is the product of a number multiplied by itself a specified number of times. For example, $3 \times 3 \times 3 \times 3 \times 3$ is called the fifth power of 3 and is written 3^5. In 3^5, the number 3 is called the *base* and 5 is called the *exponent.* The second and third powers of a number are called its *square* and its *cube* (see **Cube; Square**). The first power of a number is the number itself, and the zero power of a number is one. For example, 3^1 is 3 and 3^0 is 1. The concept of power also applies to negative numbers and fractions. For example,

$$3^{-2} \text{ is } \frac{1}{3^2} \text{ and } 3^{\frac{1}{3}} \text{ is } \sqrt[3]{3}.$$

See also **Googol; Logarithms; Scientific notation.**
Donald R. Kerr, Jr.

Power failure. See **Electric power** (Providing reliable service).

Power of attorney is a legal, written document. The signer of the document appoints an agent or attorney who has the power to act for the signer. The appointed person can act as if he or she were the actual signer rather than merely the agent of the signer (see **Agent**). When a power of attorney is officially recorded, it must generally be certified by a notary public.

The power of attorney is especially useful to people who are ill and unable to conduct their own affairs, or to people who must be away from home for a long time. In times of war, many members of the armed forces make out a power of attorney to someone at home. This is especially true of those who leave civilian business to the management of friends and relatives.

A *general* power of attorney permits the agent to act for the signer in all circumstances. A *special* power of attorney permits the agent to do only those things that the signer lists in the document. The death of the signer voids the power of attorney. Sherman L. Cohn

Power plant is any system that generates power. Power plants include the various engines used in airplanes, automobiles, locomotives, and other vehicles. Most of these power plants use gasoline or oil for fuel. Larger power plants, often called *power stations,* use coal, nuclear fuel, or oil to produce electricity.

Related articles in *World Book* include:

Airplane (Power for flight)	Gasoline engine	Rocket
Automobile (The engine)	Horsepower	Solar energy
Diesel engine	Hydraulic engine	Steam engine
Electric power	Jet propulsion	Turbine
	Locomotive	Water power
	Nuclear energy	

Power station. See **Power plant.**

Powerlifting. See **Weightlifting.**

Powers, Hiram (1805-1873), was one of the best-known American sculptors of the mid-1800's. His *Greek Slave* (1843), a full-length female nude, ranks among the most famous sculptures in American art. Praised as a symbol of beauty, virtue, and innocence, the marble statue helped establish the nude as an acceptable subject for art in the United States.

Powers was especially gifted at creating realistic portrait busts of famous people, including *Andrew Jackson* (1835) and *Henry Wadsworth Longfellow* (1869). His other works include *Fisher Boy* (1844), *California* (1850), *Benjamin Franklin* (1862), and *Thomas Jefferson* (1863). He was born in Woodstock, Vt. George Gurney

Powhatan, *pow uh TAN* or *pow HAT uhn* (?-1618), was the Indian chief in the romantic story about John Smith and Pocahontas. Smith was a soldier who had helped establish the first permanent English colony of North America, at Jamestown in what is now Virginia. Powhatan was ready to kill Smith when Pocahontas, the Indian's favorite daughter, stopped him and saved Smith's life. No one knows if this story is true. Powhatan is also famous for building the Powhatan Confederacy of Virginia (see **Powhatan Indians**).

Powhatan at first sought to use the colonists as allies against native enemies and as sources of weapons and trade goods. But the colonists' rude behavior and demands angered him. Powhatan attacked the colony repeatedly until 1614, when Pocahontas was kidnapped by the English and married John Rolfe, a settler.

Powhatan's real name was *Wahunsonacock.* But he was called Powhatan after his favorite village, which was near present-day Richmond, Va. James Axtell

See also **Pocahontas; Smith, John.**

Powhatan Indians, *pow uh TAN* or *pow HAT uhn,* formed a small but powerful tribe of eastern North America. They controlled the Powhatan Confederacy of Virginia, which once included as many as 30 tribes totaling about 9,000 people. The confederacy occupied much of what is now Virginia. The chief of the Powhatan tribe headed the confederacy. A famous chief, Wahunsonacock, was also known as Powhatan (see **Powhatan**). Jamestown, first permanent English settlement in North America, was made among the Powhatan.

The customs of the Powhatan resembled those of other eastern coast tribes. The Powhatan worshiped animal spirits, especially the Great Hare (creator).

In the early 1600's, the Powhatan often clashed with the settlers, particularly under Opechancanough (see **Indian wars** [Colonial days]). Later, the tribe seemed to no longer exist. During the mid-1900's, however, a revived confederacy was formed by several hundred Indians in Virginia and Delaware who claimed to be Powhatan.
Donald L. Fixico

Poznań, *PAWZ nahn yuh* (pop. 589,700), is a city that lies on the Warta River in west-central Poland (see **Poland** [political map]). Products of Poznań include machinery, metals, and transportation equipment. The city has two universities and many historic buildings. It was probably founded about A.D. 800. In 1956, antigovernment riots in Poznań and other Polish cities resulted in reforms that gave the people more economic, educational, and religious freedom. Janusz Bugajski

PR. See **Public relations.**

Prado. See **Madrid** (Education and cultural life).

Praetor, *PREE tuhr,* was the chief legal officer of ancient Rome. Citizens brought complaints before the praetor. The praetor decided which complaints were justified and assigned them to judges for trial. When taking office, a praetor issued an *edict* (public order) stating how the law would be interpreted in granting trials. Each new praetor generally copied or improved upon the successful edicts of earlier praetors. In that way, praetors helped to build the Roman legal system, which in turn influenced many of the legal systems used today. Praetors also served as governors of Roman provinces, and later they presided over criminal courts.

The office of praetor was created in 367 B.C. The number of praetors was increased to two in 242 B.C., and eventually increased to 16. D. Brendan Nagle

See also **Law** (Ancient Roman law).

Praetorian Guard, *pree TAWR ee uhn,* was the personal guard of the Roman emperors. Until the reign of Septimius Severus (A.D. 193-211), only soldiers recruited in Italy could serve in the guard. Septimius opened the guard to soldiers from all the Roman legions.

Emperor Augustus made the praetorians a standing army. He divided them into nine *cohorts* (groups) of a thousand soldiers each. Three cohorts remained in Rome, and the others were stationed in nearby cities. Members of the guard received much higher pay than other soldiers. The praetorians eventually became so powerful they could overthrow emperors whenever they chose. Emperor Constantine finally abolished the guard in A.D. 312. Arther Ferrill

See also **Rome, Ancient** (picture: The praetorians).

Pragmatic sanction, *prag MAT ihk SANGK shuhn,* was a type of decree concerning church or state matters issued by European rulers. The most important pragmatic sanction was privately issued by the Habsburg Emperor Charles VI in 1713 and publicly announced in 1724. At that time, German law required rulers to pass their property on to their oldest male heirs. Charles was a member of the Habsburg family. His pragmatic sanction declared that his family's holdings could be inherited by his oldest daughter if he had no sons. It also stated that the Habsburg lands could not be divided.

Several countries recognized the decree. But Charles died without a male heir in 1740, and most of these countries soon broke their pledges. Their refusal to recognize the claim of Maria Theresa, Charles's oldest daughter, to all of her father's territories led to the War of the Austrian Succession. Charles W. Ingrao

See also **Maria Theresa; Succession wars** (The War of the Austrian Succession).

Pragmatism, *PRAG muh tihz uhm,* is a philosophy that attempts to apply the methods of science to philosophy. Its central idea is that the meaning and truth of an idea are determined by the idea's effects in practice and on conduct. Three American philosophers—Charles Sanders Peirce, William James, and John Dewey—developed pragmatism. Peirce originated the philosophy, James made it popular, and Dewey extended it to key areas of life. Each of these men interpreted pragmatism in his own way.

Peirce first presented the basic ideas of pragmatism in a series of essays called "Illustrations of the Logic of Science" (1877-1878). Peirce conceived of belief as something on which we are prepared to act, not just as a state of mind. He defined belief as a *habit* or *rule of action.* He called doubt (the opposite of belief) an unsatisfactory state from which we struggle to free ourselves. For Peirce, thinking, or *inquiry,* was the struggle to eliminate the irritation of doubt. Peirce thus regarded inquiry as a practical activity—not just something that goes on in our heads. Inquiry aims to eliminate doubt by arriving at a settled belief.

Peirce's writings were technical and attracted little attention when they were published. Pragmatism as a philosophical movement began in 1898, when William James restated Peirce's ideas in more popular language. According to James's interpretation of Peirce, the concrete meaning of any abstract or general proposition can be traced to a particular concrete consequence in our future practical experience. Therefore, supposedly different ideas that have identical consequences in practice are really the same idea expressed in different words.

James's interpretation of pragmatism stated that the meaning of an abstract idea is determined by the idea's effects on one who believes it. James wrote that a true idea is one that can be verified, that "works," and that satisfies. According to this concept, truth is changeable. Because a true idea is one that agrees with reality, James concluded that we can make ideas true by our actions and change the world in which we live.

John Dewey was greatly influenced by the English biologist Charles Darwin and Darwin's theory of evolution. Dewey conceived of thought and of the mind as instruments developed in the course of evolution to allow human beings to reshape their environment. Dewey's version of pragmatism, later called *instrumentalism,* stated that all ideas are instruments. Therefore, true ideas are those that work best for attaining human goals. Dewey urged that philosophy become a tool for dealing with the specific problems of all human beings rather than with the remote problems of philosophers. Dewey advocated that the method of science be used to reshape education, morals, politics, and society.

Pragmatism became the most important philosophical movement in the United States during the early 1900's, and it has had an enormous influence on American life. Pragmatism has been called a typically American philosophy because of its basic optimism, its emphasis on action, and its belief in a future that can be changed by human ideas and efforts. Many people claim that pragmatism expresses the essential American character.

Marcus G. Singer

See also **Peirce, Charles Sanders; James, William; Dewey, John.**

Additional resources

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Prague, *prahg* (pop. 1,215,656), is the capital and largest city of the Czech Republic and an important center of culture and learning. Prague, called Praha in the Czech language, is one of the oldest and most beautiful cities in central Europe. It lies on the Vltava River, in the central part of the country (see **Czech Republic** [map]).

Prague is called the "City of a Hundred Spires" because of its many churches. It was one of the few central European cities that escaped major damage during World War II (1939-1945).

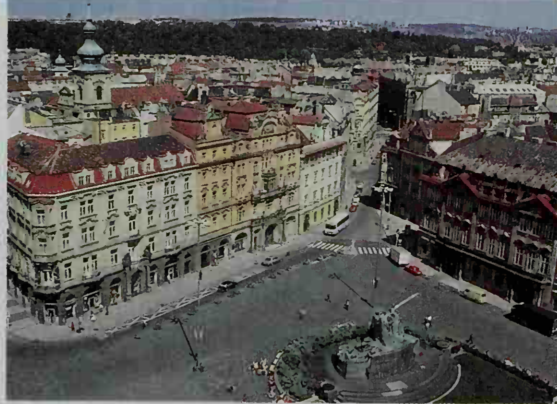
The city lies on both banks of the Vltava River. A number of bridges connect the two sections of Prague. The Charles Bridge, a stone structure lined with statues of saints, is the most famous one. The city covers about 70 square miles (180 square kilometers). Much of the city's area is made up of scenic hills.

Prague Castle, once the home of the kings of Bohemia, stands on *Hradčany* (Castle Hill) on the left bank of the Vltava River. Prague Castle houses a number of art treasures, and part of the castle serves as the official residence of the president of the Czech Republic. St. Vitus' Cathedral also stands on Hradčany. Many beautiful old palaces and other structures line the narrow, winding streets of Malá Strana, a district of Prague that is located on the slopes and at the bottom of the hill.

Old Town, the historic center of Prague, lies on the right bank of the Vltava, across from Hradčany. Old Town Hall and the Týn Church are in Old Town Square. Old Town Hall, built during the 1300's, served as the seat of the city government for hundreds of years. It has a famous clock with statues of the 12 apostles that move every hour. A monument to John Hus, a religious reformer of the early 1400's, stands in the middle of the square. The Týn Church was the main church of the Hussite reformers (see **Hus, John**). Many buildings of Charles University, founded in 1348 by King Charles IV of Bohemia, are in Old Town.

The business center of Prague is in New Town, also located on the right bank of the river. Much of the New Town area was built during the 1800's. Its Wenceslas Square—which is actually a wide boulevard lined with hotels, restaurants, and shops—is the busiest street in Prague. The National Museum occupies one end of Wenceslas Square. A statue of Saint Wenceslas stands in front of the museum. Prague also has many other museums, as well as libraries, theaters, opera houses, and concert halls.

Residential neighborhoods lie north, south, and west of Prague. Factories have been built chiefly in the eastern and southern suburbs.



Jessie Blackburn, FPG

Prague's Old Town Square is lined with historic buildings. A memorial to religious reformer John Hus is in the foreground.

People. Most of Prague's people are Czechs. The city had a large German community before World War II, but most of the Germans were expelled after the war. Because of government restrictions on migration to Prague and a low birth rate, the size of the population has increased only slightly since the war ended.

Prague has a housing shortage. Many houses in the city were built during the early 1900's and are in poor condition. Since the mid-1900's, the government has constructed many apartment buildings in the suburbs. But many people still live in crowded city apartments.

Economy. Prague ranks as one of the country's leading manufacturing centers. The city's most important industrial products include aircraft engines, automobiles, beer, chemicals, diesel engines, furniture, machine tools, optical instruments, processed food, and streetcars. Prague also is an important railroad center.

History. Prague was probably founded during the A.D. 800's. It soon grew into an important trading center. In time, the city became the residence of the Bohemian kings, who were crowned in St. Vitus' Cathedral. King Charles IV, who also ruled the Holy Roman Empire, erected many important buildings. He founded the first university in central Europe in Prague in 1348. The Hussite religious reformation began in Prague during the 1400's, and Prague suffered much damage in the religious wars that followed.

The Thirty Years' War began in Prague in 1618 after Protestant Bohemians rebelled against the Roman Catholic Habsburg (or Hapsburg) emperor. The revolt failed, and the Habsburgs ruled Prague until the end of World War I in 1918. That year, the city became the capital of the new nation of Czechoslovakia.

German troops occupied Prague during World War II. Many of Czechoslovakia's people, including thousands of Jews, were killed by the Germans. In 1945, at the end of the war, the Soviet Army entered Prague. The Czechoslovak Communist Party, supported by the Soviets, took control of Czechoslovakia in 1948.

For a brief period in 1968, Prague was the center of a liberal reform movement, sometimes called the *Prague Spring,* in Czechoslovakia. The movement ended after tanks and soldiers from the Soviet Union and several other Eastern European Communist countries swept into Prague. In the late 1980's, Prague was also the center of the movement that led to the end of Communist control of Czechoslovakia. In 1993, the independent countries of the Czech Republic and Slovakia were formed to replace Czechoslovakia. Prague remained the capital of the Czech Republic. Vojtech Mastny

Prairie is a region of flat or hilly land covered chiefly by tall grasses. The pioneers who first saw the flat prairies of the American Middle West described them as a "sea of grass." The wind blew gentle waves in a green carpet of grasses. In some places, the grasses grew taller than an adult. Today, corn and wheat fields cover most of the prairie. Few prairies remain untouched.

The North American prairie extends from central Texas to southern Saskatchewan. It includes most of Oklahoma, Kansas, Nebraska, Iowa, Illinois, South Dakota, and North Dakota, and parts of other nearby states and provinces. Alberta, Saskatchewan, and Manitoba are called the "Prairie Provinces" of Canada. Other prairies include the Pampa of Argentina, the *veld* of



Prairies are covered chiefly by tall grasses. Few natural prairie regions remain in the world because most of them have been turned into farms or grazing land. The prairie shown at the left lies in Waterton Lakes National Park in Alberta, Canada.

Artstreet

South Africa, the Canterbury Plains of New Zealand, and parts of Hungary, Romania, Russia, and Ukraine.

Climate and soil. Prairies have hot summers, cold winters, and moderate rainfall. Summer temperatures may reach well over 100 °F (38 °C) and winter temperatures may drop as low as −40 °F (−40 °C). Tropical grasslands, where temperatures vary less from summer to winter, are called *savannas* (see **Savanna**). Most prairies receive from 20 to 35 inches (51 to 89 centimeters) of rain a year—less than forests get but more than *steppes* (regions of short grasses) receive. Most of the rain falls in late spring and early summer.

Prairie soils have especially deep, dark, fertile upper layers. Such soils result from the growth and decay of deep, many-branched grass roots. The rotted roots hold the soil together and also provide a source of food for living plants. The richest, blackest prairie soils are called *chernozems.* This term comes from a Russian word meaning *black earth.*

Life on the prairie. The thick cover of grasses of the American prairie consists of many species. Each kind of grass grows best in a certain kind of environment but also occurs in other places. For example, slough grass is found in low, marshy ground. Big bluestem, Indian grass, switch grass, and wild rye thrive in fairly moist areas. Drier areas have little bluestem, dropseeds, June grass, blue grama, needlegrasses, and side oats grama. In the moist eastern parts of the prairie, near forested areas, the grasses may grow 6 feet (1.8 meters) high or even taller. On the dry western edge, the grasses grow only about 2 feet (61 centimeters) high. There, the prairie gradually changes to a steppe.

Many kinds of nonwoody plants other than grasses also grow on the prairie. Hundreds of species of flowers add splashes of yellow, orange, red, purple, and other colors to the sea of grass. Many of these wildflowers belong to the *composite* family or to the *legume* family of plants. Composites that grow on the prairie include such flowers as asters, blazing stars, coneflowers, goldenrods, and sunflowers. Prairie legumes include clovers, psoraleas, and wild indigos. A purplish phlox and an orange-flowered milkweed called butterfly weed also color the prairie.

Cattails and sedges rustle in the breeze in marshy areas and near lakes and ponds on the northern prairie. Some woody shrubs, such as the prairie rose, grow among the grasses. A few trees, including cottonwoods, oaks, and willows, grow in river valleys on the prairie.

Many animals feed on the leaves, roots, and seeds of prairie plants. Some of these animals, such as jack rabbits, deer, and pronghorns, use their speed to escape from enemies. Others, including mice and prairie dogs, hide in underground burrows. Such birds as blackbirds, grouse, meadowlarks, quail, and sparrows build their nests in a thick cover of plants. Until the late 1800's, large herds of bison—commonly called buffaloes—roamed the American prairie.

Coyotes, foxes, and skunks feed both on smaller prairie animals and on certain plants. Badgers, hawks, owls, and some species of snakes eat meat almost entirely. Insects—especially grasshoppers and leafhoppers—and spiders are also common on the prairie.

The soil of the prairie contains millions of tiny organisms that feed on dead plants and animals. These organisms include bacteria and fungi as well as such soil animals as centipedes, earthworms, mites, and nematodes. All of them speed the process of decay among the dead plants and animals. This decaying process provides the soil with food for future generations of prairie plants.

René W. Barendregt

See also **Grassland; Pampa; Steppe.**

Prairies

The world's largest prairie lies in North America. This map also shows other large prairie regions of the world.



Prairie-chicken is the name of two species of North American grouse. These birds live in the central and western plains of the United States. The *greater prairie-*



Dave Spier, Tom Stack & Assoc.

Prairie dogs keep a sharp lookout for their enemies. The black-tailed prairie dogs pictured here have gathered at an entrance to one of their burrows. Prairie dogs live in large groups called *colonies* or *towns.*

chicken is about 18 inches (46 centimeters) long and weighs about 2 pounds (0.9 kilogram). Its feathers are yellowish-brown and white above, crossed with black bars, and white and brown barred below. Its head is deep buff with brown stripes. The *lesser prairie-chicken* is somewhat smaller, measuring about 16 inches (41 centimeters) long. Its feathers are paler than those of the greater prairie-chicken.

Prairie-chickens have unusual courtship habits. The male bird erects the feather tufts on his neck, spreads and raises his tail, and stretches out his wings and allows them to droop. He inflates two pouches on the side of his throat and makes a hollow booming noise. The male also leaps and dances during the courtship period.

The number of prairie-chickens has decreased greatly since the mid-1800's, chiefly because their habitats have been turned into farmland. The lesser prairie-chicken inhabits the southern Central Plains, from Kansas to Texas. The Greater prairie-chicken now lives in isolated areas from Michigan and Illinois westward to the Great Plains. They once lived as far east as Massachusetts. The heath hen, a subspecies of the greater prairie-chicken, has been extinct since the 1930's. Bertin W. Anderson

Scientific classification. Prairie-chickens belong to the family Phasianidae. The greater prairie-chicken is *Tympanuchus cupido;* the lesser prairie-chicken is *T. pallidicinctus.*

See also **Bird** (picture: Birds of grasslands); **Grouse.**

Prairie dog is a burrowing rodent that lives in western North America. It belongs to the squirrel family. The animal gets its name from the *prairies* (grassy plains) where it lives, and from its warning call, which sounds like a domestic dog's bark.

Prairie dogs have short legs; long, sharp claws; small eyes at the top of the head; and a short tail. Their thick fur is light brown. Adults measure from 9 to 15 inches (23 to 38 centimeters) in length, including the tail, and weigh from 1 to 3 pounds (0.5 to 1.4 kilograms).

There are five *species* (kinds) of prairie dogs. The *Black-tailed prairie dog,* the most common kind, inhabits the Great Plains from southern Canada to northern Mexico.

Habits. Prairie dogs live in burrows. They come out of their burrows only in the daytime to eat. Their diet consists mostly of plants, especially grasses. Occasionally they eat grasshoppers and other insects.

Prairie dogs are social animals. They live in large groups called *colonies* or *towns* that may contain more than 500 residents. Each colony of black-tailed prairie dogs contains many family groups called *coteries.* A typical coterie consists of one adult male, three or four adult females, and several offspring. Coterie members defend their territory by fighting or chasing off trespassing prairie dogs from other groups. A territory usually has 25 to 50 burrows, some as deep as 16 feet (5 meters). Most burrows have at least two entrances surrounded by mounds. The mounds protect burrows from flooding, improve underground ventilation, and provide prairie dogs with perches to watch for predators.

The enemies of prairie dogs include American badgers, bobcats, coyotes, red-tailed hawks, golden eagles, and prairie falcons. When a prairie dog sees a predator, it commonly gives a loud alarm. Other prairie dogs then run to their burrow mounds to watch the predator. They only submerge underground if the predator approaches within 10 to 15 feet (3 to 4.6 meters).

Black-tailed prairie dogs mate in the winter. The female carries her young for about 34 days and then gives birth to one to six blind, hairless babies. The young stay underground for about 6 weeks before they emerge from their burrows. Males leave the original coterie when they are about 12 months old, and each attempts



Brian Parker, Tom Stack & Assoc.

The black-tailed prairie dog has a tail tipped with black fur. This prairie dog lives in an area of the Great Plains from southern Canada to northern Mexico.

to take over a coterie from an older male. Most females remain in the original coterie for life. About half of all prairie dogs die before they are 1 year old. Males that survive the first year sometimes live five years, and females eight.

Prairie dogs and people. Over time, ranchers and other people have reduced prairie dog populations by killing them and destroying their habitats. All five prairie dog species have now become threatened with extinction. Ranchers traditionally feared their livestock would step into prairie dog burrows and suffer leg injuries. They also believed prairie dogs ate grasses and other plants preferred by cattle. Yet horses and cows rarely step into burrows, and prairie dogs generally eat different plants than livestock eat. Moreover, prairie dog activities improve the quality of certain plants. For example, the animals expose subsoil when they dig, making the land more fertile. Thus livestock commonly prefer to feed within prairie dog colonies. More research is needed to better understand the relationship between prairie dogs and livestock. John L. Hoogland

Scientific classification. Prairie dogs belong to the squirrel family, Sciuridae. The black-tailed prairie dog is *Cynomys ludovicianus.* The other four species are *C. gunnisoni, C. leucurus, C. mexicanus,* and *C. parvidens.*

See also **Animal** (picture: Prairie dogs); **Gopher; Ground squirrel; Rodent; Squirrel.**

Prairie Provinces are the three Canadian provinces of Alberta, Saskatchewan, and Manitoba. These provinces make up a large region that borders Montana, North Dakota, and Minnesota. The Prairie Provinces cover a total of 758,100 square miles (1,963,470 square kilometers), or about a fifth of Canada.

The three provinces have more than three-fourths of Canada's farmland and provide much of the nation's cattle and grain. The region also has rich deposits of petroleum and many other minerals. Several cities in Alberta and Manitoba are important manufacturing centers.

About a sixth of Canada's people live in the Prairie Provinces. The 2001 Canadian census reported that the region had a population of 5,073,323, of whom about three-fourths lived in cities or towns. The population included about 180,000 people with American Indian ancestry, or about a third of the Indians in Canada. The largest cities of the region are, in order of size, Calgary, Alberta; Edmonton, Alberta; Winnipeg, Manitoba; Saskatoon, Saskatchewan; and Regina, Saskatchewan.

Economy. A majority of the income of the Prairie Provinces comes from industries that provide services rather than produce goods. However, agriculture and mining are more important to the region than they are to Canada as a whole.

Prairie farmers raise almost all of Canada's barley, wheat, and oats, and about three-fourths of the beef cattle. Cattle sales provide about a fourth of the region's farm income. Major farm products also include canola, corn, dairy goods, hogs, peas, potatoes, and poultry.

The Prairie Provinces produce about 90 percent of Canada's natural gas and petroleum, and the region has about half the known coal deposits in the nation. The majority of coal, gas, and oil produced in the region comes from Alberta. Southern Saskatchewan has the largest known potash deposits in the world. Thompson, Manitoba, ranks as one of the world's chief centers of nickel production. Other mined products of the Prairie Provinces include cobalt, copper, gold, quartz, salt, sand and gravel, sodium sulfate, uranium, and zinc.

The production of chemicals is the leading manufacturing activity in the Prairie Provinces. Other important manufactured goods include electrical equipment, fabricated metal products, machinery, printed materials, and processed foods and beverages.

Commercial fisheries operate on a number of lakes in the Prairie Provinces. Fur farmers and trappers of the region market valuable pelts. Airlines, highways, and railroads link the cities and towns of the Prairie Provinces. Ships carry cargo between Churchill, Manitoba, and Atlantic Ocean ports by way of Hudson Bay.

History. A number of American Indian tribes lived in what are now the Prairie Provinces when white explorers first arrived there. Major tribes included the Assiniboine, Blackfoot, Chipewyan, and Cree.

The English explorer Sir Thomas Button and his crew were probably the first white people to see the region. In 1612, they sailed down the west coast of Hudson Bay and claimed the land for England. In 1670, King Charles II of England granted control of most of what are now the Prairie Provinces to the Hudson's Bay Company of London, a fur-trading organization. The fur trade was the region's major economic activity for the next 200 years.

In 1869, the Hudson's Bay Company sold the region to the newly formed Dominion of Canada. Manitoba became a province in 1870, when the Dominion of Canada took possession of the region. In the late 1800's and early 1900's, millions of people settled in the region. They came from eastern Canada, the United States, and such European areas as Britain, Germany, the Netherlands, Poland, Scandinavia, and Ukraine. Alberta and Saskatchewan became provinces in 1905. Roderick C. Macleod

See also the articles on each of the Prairie Provinces and their lists of *Related articles.*

Prairie schooner. See **Pioneer life in America** (The wagon train).

Prairie wolf. See **Coyote.**

Praseodymium, *PRAY zee oh DIHM ee uhm* (chemical symbol, Pr), is one of the rare-earth elements. Its atomic number is 59, and its atomic weight is 140.90765. At 25 °C, its density is 6.475 grams per cubic centimeter (see **Density**). Austrian chemist C. F. Auer von Welsbach first discovered praseodymium in 1885, when he separated salts of the so-called element didymium into praseodymium and neodymium. The name *praseodymium* comes from the Greek words *prasios,* meaning *leek-green,* and *didymos,* meaning *twin.* The element received this name because it occurred in the green fraction, or part, of didymium. It is best separated from the other rare-earth elements by ion-exchange or solvent extraction processes.

Praseodymium melts at 931 °C and boils at 3520 °C. It makes a useful alloy, especially in *misch metal* (a mixture of rare earths). Praseodymium oxide is a black powder that dissolves in acid to form green solutions or green salts. These salts are used in the ceramics industry for coloring glass and for glazing. Larry C. Thompson

See also **Element, Chemical** (table); **Rare earth.**

Pratt, E. J. (1882-1964), was a Canadian poet known for his epics of Canadian history and his narrative poems. The typical hero of his works is a group or community.

His first book, *Newfoundland Verse* (1923), marks his lifelong interest in the sea as a world of primitive clashes. *The Titanic* (1935) retells the story of the ocean liner that sank in 1912.

In *Brébeuf and His Brethren* (1940), Pratt wrote about Jesuit missionaries in Canada during the 1600's. *Towards the Last Spike* (1952) is an account of the construction of the Canadian Pacific Railway. Pratt's best works have been brought together in *The Collected Poems of E. J. Pratt* (1958). Edwin John Pratt was born on Feb. 4, 1882, in Western Bay, Newfoundland (now Newfoundland and Labrador), near Carbonear. Laurie R. Ricou

See also **Canadian literature** (Literature between the world wars).

Prawn. See **Shrimp**.

Praxiteles, *prak SIHT uh leez,* was one of the greatest Greek sculptors of the 300's B.C. He was one of the first sculptors to humanize the Greek gods and goddesses, a departure from the stern, remote, awe-inspiring figures of previous Greek sculptors.



National Museum of Athens (Raymond V. Schoder, S.J.)

Hermes is a Roman copy of a statue by Praxiteles. It shows the sculptor's lifelike style.

Praxiteles excelled in sculpting the beauty of the human form. Face and body features were delicately lifelike, and the marble surfaces had a lustrous finish. The eyes of his figures had a dreamy look. The hip was often thrust out, creating a graceful "S" curve, and giving the body a more relaxed appearance.

Although none of Praxiteles's work has survived, Greek and Roman copies of his sculptures exist that are excellent representations of his style. One famous copy is a statue of Hermes and the infant Dionysus (see **Hermes**). In antiquity, Praxiteles's most famous statue was the Aphrodite of Knidos. The statue was the earliest to show the goddess of love standing nude, modest but alluring. Praxiteles's Aphrodite was the inspiration for many later statues of the goddess. Praxiteles was born in Athens.

Marjorie S. Venit

Prayer refers to reverent words and thoughts directed toward God, gods, goddesses, or other objects of worship. People pray to ask for spiritual benefits for themselves or others. They also offer praise, thanks, or adoration to the object of worship. Prayers may take the form of speech, song, dance, or silent reverence. Some people kneel while praying. Others stand, sit, or lie down. Prayer is an important form of worship in nearly all the religions in the world. Most religions have regular prayers for both community and private worship. Individuals may also offer private prayers that express personal thoughts. *Contemplation* is prayer in which a person concentrates only on the object of worship.

Jill Raitt

See also **Religion** (Religious rituals); **Lord's Prayer; Rosary; School Prayer; Meditation.**

Praying mantis. See **Mantid**.

Preachers, Order of. See **Dominicans**.

Preamble. See **Constitution of the United States** (Preamble); **United Nations** (The preamble to the Charter of the United Nations).

Precipitation. See **Hail; Rain; Sleet; Snow; Weather.**

Predator. See **Balance of nature**.

Predestination is the belief that God foresees and wills from all eternity that some individuals will be saved. Other terms for predestination include *election* and *foreordination*. The belief that God predestines some people for salvation and others for damnation is called *double predestination*. Both Christianity and Islam include a belief in predestination. This article deals with predestination in Christianity.

The doctrine of predestination has been a problem in Christian theology since the time of Saint Augustine, in the early 400's. The problem arises from the apparent conflict between the beliefs that God is all-powerful and that human beings have free wills. Some theologians have stressed the importance of human freedom, and others have emphasized God's power and grace in salvation. Augustine wrote that salvation is initiated only by God's freely given grace. In the 1500's, Martin Luther and other leaders of the Protestant Reformation taught that salvation depends entirely on God's all-powerful will. They believed that nothing humanity did could require God to grant salvation in return. The Protestant leader John Calvin taught the doctrine of double predestination.

Some people have criticized the doctrine of predestination as being negative and pessimistic. But Luther, Calvin, and others saw it as a doctrine that should free people from constantly worrying about and struggling to earn salvation. Because salvation is in God's hands, they believed, the individual should stop being anxious and simply trust in God. Albert J. Raboteau

See also **Free will; Grace.**

Preeclampsia, *pree uh KLAMP see uh,* is a serious condition that affects about 5 percent of pregnant women. Preeclampsia can interfere with growth of the *fetus* (unborn baby) and lead to premature birth. It may result in the death of the mother, her unborn baby, or both. Symptoms usually occur late in pregnancy. They include high blood pressure, excessive protein in the urine, and body swelling. Preeclampsia was formerly called *toxemia of pregnancy*.

The cause of preeclampsia is unknown. Certain conditions, including overweight and diabetes, increase a woman's risk of developing preeclampsia. Good medical care during pregnancy detects most cases before they become severe. Preeclampsia can cause abnormal development or death of the fetus by restricting circulation of the mother's blood to the *placenta*. The placenta is the organ that transfers food and oxygen from the mother's blood to the fetus's blood.

Untreated preeclampsia may progress to *eclampsia*, an even more serious condition in which women suffer convulsions. Such symptoms as headache, abdominal pain, and extremely high blood pressure may appear before convulsions, or convulsions may occur without warning. Other dangers of eclampsia include

kidney failure, liver damage, and bleeding in the brain.

Doctors treat preeclampsia by prescribing bed rest and other measures that lower the patient's blood pressure. Some cases must be treated in a hospital. If warning signs of eclampsia develop, doctors give drugs to prevent convulsions. They also end the pregnancy early, by delivering the fetus surgically or using drugs to stimulate labor. After the pregnancy ends, the patient usually recovers rapidly. Marshall D. Lindheimer

Pre-emption is the act of buying something ahead of other persons, or the right to do so. The term comes from two Latin words, *emptio,* meaning *buying,* and *pre,* meaning *before.* Pre-emption had special meaning in the United States in the 1800's. People called *squatters* moved into unsettled areas and built on land they did not own. Real estate speculators called *claim-jumpers* often worked with lawyers to take the squatters' land.

Beginning about 1800, Congress granted the right of pre-emption to some squatters. In 1841, Congress passed a pre-emption law that applied to all squatters. Squatters who lived on surveyed government land and made improvements on it had the right to buy that land before anyone else could do so. When the land they occupied was offered for sale, they could buy up to 160 acres (65 hectares) of it for $1.25 an acre.

A person who already owned as much as 320 acres (129 hectares) of land could not get more by pre-emption. A married woman living with her husband could not get any land by pre-emption, and neither could a person who moved within the same state.

After the American Civil War (1861-1865), big land companies sent out "dummy" settlers, who filed applications for land which they did not intend to keep as their own. In return for a cash payment from a land company, a dummy settler would file a claim, live on the land for six months, buy it for an absurdly low price, and hand it over to his or her employer. Then the dummy settler would file another claim.

Congress abolished pre-emption in 1891. During the years the system was in force, about 200 million acres (81 million hectares) of land passed from the government to private owners. Dennis L. Thompson

See also **Homestead Act; Public lands; Squatter's rights; Tyler, John** (Tyler's accomplishments).

Pregnancy, also called *gestation,* is the period when a female carries a developing baby within her body. The females of almost all species of mammals have a period of pregnancy before giving birth. In human beings, pregnancy normally lasts about nine months.

Pregnancy begins when an *egg* (female sex cell) and a *sperm* (male sex cell) unite in a woman's body. This union, called *conception,* forms a single cell called a *fertilized egg.* The fertilized egg attaches itself to the lining inside the woman's *uterus,* a hollow, muscular organ in the abdomen. During the next nine months, the egg develops within the uterus into a fully formed baby. From about the third week to the eighth week after conception, all the baby's major organs begin to form. During this time, the baby is called an *embryo.* From the ninth week until birth, the baby's body grows in size while its organs mature. During this period, the baby is called a *fetus.* Pregnancy ends when the baby passes out of the mother's body at birth.

This article discusses pregnancy and the experiences of the expectant mother up to the baby's birth. For detailed information on the development of the baby during pregnancy and on the birth process, see **Baby; Reproduction, Human;** and **Childbirth.**

Becoming pregnant

A woman usually becomes pregnant by means of sexual intercourse. In sexual intercourse, a man's penis discharges *semen*—fluid containing sperm—in the woman's vagina. Pregnancy begins if a sperm penetrates an egg.

In addition, scientists have developed techniques that enable women to become pregnant without sexual intercourse. For example, in a process called *in vitro fertilization,* sperm are collected from a man and used to fertilize eggs in a laboratory dish. The eggs are then inserted into the woman's uterus.

Planning for pregnancy. Medical experts recommend that women who plan to become pregnant seek medical advice before conception, as much as a year before pregnancy. A woman should choose a health care provider skilled in giving such advice and in providing medical care during pregnancy. This person may be either a physician who is qualified to care for pregnant women or a *nurse-midwife.* In the United States, a nurse-midwife is a registered nurse specially trained and certified to care for pregnant women.

During the initial pregnancy visit, the woman provides information about her present health, past illnesses and pregnancies, and her family medical history. The health care provider gives the woman a thorough physical examination and orders certain medical tests. For example, blood and urine tests check for diseases or conditions in the mother that can harm a developing baby, including anemia, hepatitis B, syphilis and other sexually transmitted diseases, and *rubella* (German measles). One important blood test determines if the mother and baby have the same *Rh factor,* a substance on red blood cells. If they have different Rh factors, the baby may develop a serious blood disorder. See **Rh factor.**

The doctor or midwife counsels the woman about risks to the pregnancy based on her health, habits, medical history, or age. Women who have certain disorders in their family histories or who are over 35 may be advised to seek additional counseling to determine the chances of bearing a child with genetic defects.

Confirming pregnancy. For the majority of women, the first sign of pregnancy is a missed *menstrual period.* A menstrual period is the time when a woman *menstruates* (discharges blood and tissue through the vagina). Each month, the lining of the uterus thickens in preparation for pregnancy. If the woman does not become pregnant, the lining breaks down and menstruation occurs. If the woman becomes pregnant, however, the thickened lining remains intact, helping to sustain the developing baby. As a result, menstruation stops after conception and resumes after the baby is born.

A woman who suspects she may be pregnant should have a pregnancy test as soon as possible. Pregnancy tests check for a hormone called *human chorionic gonadotropin* (hCG) in the woman's blood or urine. This hormone is first produced by the fertilized egg and later by the *placenta,* an organ that forms in a pregnant woman's uterus. The placenta enables the baby to



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A childbirth class helps expectant mothers and their partners prepare for labor and delivery. Such classes provide a realistic preview of the birthing process and teach natural pain-control techniques for use during childbirth.

obtain food and oxygen from the mother's blood.

Blood tests performed in a laboratory can verify pregnancy as early as about seven days after conception. Women can test their urine for hCG using a home pregnancy test kit. Such tests are accurate beginning about the time of the woman's first missed menstrual period. However, a qualified health care provider should confirm the results of a home pregnancy test.

Estimating the date of birth. The health care provider uses the date of the expectant mother's last menstrual period to estimate when the baby will be born. The birth typically is calculated to occur 280 days, or 40 weeks, from the first day of the woman's last menstrual period. Throughout pregnancy, the estimated birth date may be adjusted somewhat based on the size of the uterus and other factors.

How pregnancy affects women

During pregnancy, a woman's body undergoes enormous changes. Many changes result from increased levels of the hormones *estrogen* and *progesterone* in the woman's blood. During pregnancy, these hormones are secreted into the bloodstream primarily by the placenta. The placenta also produces certain other hormones that trigger changes in a woman's body. To help describe when changes occur in the woman and her developing baby, pregnancy is often divided into three three-month periods called *trimesters.*

Weight gain. Women normally gain between 25 and 35 pounds (11 and 16 kilograms) during pregnancy. Several factors affect the amount gained, including a woman's weight at the start of pregnancy and the number of babies she is carrying. At birth, the baby accounts for about $6\frac{1}{2}$ to 8 pounds (3 to 3.5 kilograms) of the weight gained and the placenta about 1 to $1\frac{1}{2}$ pounds (0.5 to 0.7 kilogram). The rest of the weight is mainly fat, blood and other fluids, and extra tissue in the breasts and uterus.

Changes in breasts. A woman's breasts change in certain ways throughout pregnancy so that they can produce milk to feed the baby after birth. For example, the glands in the breasts that make the milk and the *ducts* (tubes) that carry the milk to the nipples both enlarge. The breasts themselves become larger and more tender. The *lactation* (milk-making) process begins soon after the baby is born.

Changes in the uterus prepare a woman's body for the birth process, also called *labor.* During labor, contractions of the uterus and abdomen push the baby out of the woman's body through the vagina.

The uterus expands to about 24 times its normal size during pregnancy, mostly because the muscle cells in the wall of the organ increase in size. Around the sixth month of pregnancy, the uterus begins to have irregular contractions that may be mild or intense.

Other common symptoms of pregnancy. During the first trimester, hormonal changes cause many women to experience *morning sickness* (nausea and vomiting). By about the fourth month, however, morning sickness usually lessens or disappears.

Many pregnant women experience increased fatigue and the need to urinate frequently. Hormonal changes, weight gain, and other changes in the woman's body contribute to fatigue. Frequent urination results mainly from the expanding uterus pressing on the bladder.

Other symptoms caused or made worse by the uterus pressing on organs include back pain, shortness of breath, discomfort in the pelvic region, heartburn, and constipation. In addition, *varicose veins* (enlarged veins in the legs) and *hemorrhoids* (enlarged veins around the anus) may occur.

Prenatal care

A pregnant woman's health and habits can affect the growth and development of her baby. The term *prenatal care* refers both to medical care during pregnancy and to an expectant mother's healthful lifestyle. Good prenatal care helps protect the health of the unborn baby.

Medical care. A woman who becomes pregnant should receive periodic physical examinations and tests.

Routine examinations. During each physical examination, the health care provider checks the mother's

weight, blood pressure, heart rate, and general physical condition. He or she listens to the baby's heartbeat and measures and feels the mother's abdomen to determine the growth and position of the fetus. Routine checkups also include a urine test to check for *preeclampsia,* a serious condition that can occur later in pregnancy, and *gestational diabetes,* a disorder that impairs the body's ability to use sugar normally.

Special tests. The health care provider may order one or more special tests. One of the most common of these is an *ultrasound examination.* In this examination, special equipment produces ultrasonic waves that reflect off the fetus. The returning echoes produce an image of the fetus on a screen. Ultrasound testing can help confirm the position and growth of the fetus and determine the number of babies the mother is carrying.

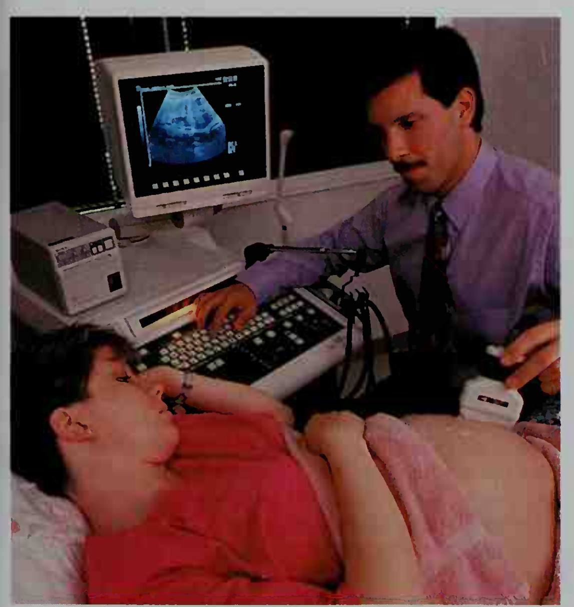
Special tests also may be given to determine whether the fetus has certain genetic defects, such as Down syndrome. In a test called *amniocentesis,* a physician takes a sample of the *amniotic fluid,* the watery liquid in the protective sac that forms around the baby. The fluid contains cells shed by the baby that can be tested for genetic disorders. In *chorionic villus sampling,* a sample of the placental tissue is analyzed for abnormalities. See **Amniocentesis; Genetic counseling.**

Lifestyle during pregnancy. In general, a pregnant woman should eat a well-balanced diet, get plenty of sleep, and exercise regularly at a mild or moderate level. Doctors also recommend taking extra amounts of certain vitamins and minerals. Expectant mothers should not eat undercooked meat. Such meat may contain parasites that cause *toxoplasmosis,* a disease that can severely damage a developing baby. A cat's body waste can also spread toxoplasmosis. As a result, pregnant women should not touch dirty cat litter.

Any chemical in the expectant mother's blood can enter the developing baby's bloodstream through the placenta. Some chemicals damage the developing baby or interfere with its growth. For this reason, pregnant women should not take medications, including over-the-counter drugs such as aspirin and nasal spray, unless advised to by a health care provider. Nonmedicinal drugs, alcoholic beverages, and cigarette smoke should also be avoided.

Pregnant women should avoid X rays and exposure to hazardous chemicals. They should also avoid excessive heat, such as in hot tubs or saunas. The body's effort to keep cool in such heat can result in blood—and therefore oxygen—being drawn away from the uterus.

A pregnant woman can help herself, as well as her baby, by learning about labor and delivery. Childbirth classes provide a realistic preview of the birth process and teach natural pain-control techniques, such as breathing and relaxation. These methods can reduce or eliminate the need for pain medication during labor.



Kevin Beebe, Custom Medical

An ultrasound examination uses sound waves to produce an image of the fetus on a computer screen. Such testing can confirm the position and growth of the fetus.

Complications

Common complications of pregnancy include (1) miscarriage, (2) ectopic pregnancy, (3) preeclampsia, and (4) premature birth.

Miscarriage, also called *spontaneous abortion,* is the unintentional early ending of pregnancy by a natural cause before the 20th week of pregnancy. In a miscarriage, the embryo or fetus is expelled from the body by contractions of the uterus. More than 20 percent of pregnancies end in miscarriage. The majority of miscarriages occur during the first trimester.

Abnormalities in the embryo or fetus cause most miscarriages. Physical problems in the expectant mother also cause many miscarriages. Such problems, which usually cause more miscarriages later in the pregnancy than do fetal abnormalities, include infections; disorders of the immune system, cervix, or uterus; and diabetes or other diseases. Medical care before and during pregnancy can prevent some miscarriages.

An ectopic pregnancy occurs when a fertilized egg implants itself outside the uterus, usually inside the *fallopian tube,* the tube through which the egg passes on its way from the ovary to the uterus. The developing baby cannot survive in an ectopic pregnancy. The pregnancy may be fatal to the mother if untreated.

Preeclampsia, *PREE uh KLAMP see uh,* formerly called *toxemia of pregnancy,* is one of the most serious conditions that can occur during the later months of pregnancy. Its cause is unknown. Physical symptoms include high blood pressure, headaches, sudden and excessive weight gain, and swelling, especially of the face, feet, and hands. If untreated, preeclampsia can lead to *eclampsia,* a condition that can result in the death of the mother, the baby, or both.

Premature birth. Some infants are born *prematurely*—that is, before the 37th week. The more premature a baby is, the less it weighs and the higher its risk of death. A pregnant woman can lessen the risk of some premature births by good prenatal care.

Lynn J. Romrell

Related articles in *World Book* include:

Abortion	Fallopian tube	Miscarriage
Adolescent (Pregnancy)	Infertility	Placenta
Birth defect	Menstruation	Preeclampsia
	Midwife	Premature birth

Prehistoric animal

Prehistoric animal refers to any animal that existed more than 5,500 years ago, before human beings began recording their history in writing. Some prehistoric animals greatly resembled their present-day relatives. Many ancient creatures, however, were unlike anything alive today. Dinosaurs rank among the best-known prehistoric animals. One dinosaur, *Seismosaurus* (pronounced *SYZ muh SAWR uhs),* may have grown up to 150 feet (45 meters) in length. Other unusual creatures included flying reptiles, sea scorpions 8 feet (2.4 meters) long, and hairy relatives of elephants called *mammoths.* Not all of these animals lived at the same time.

The long history of animals is recorded by *fossils.* Fossils are the remains of prehistoric life. They include the bones, shells, and tracks of animals, as well as petrified wood and impressions of leaves. Fossils help scientists called *paleontologists* learn what prehistoric animals looked like and when, where, and how they lived. Paleontologists use fossils to compare prehistoric animals with living ones. Such comparisons help people understand how ancient and modern animals are related.

The oldest known animal remains date from about 600 million years ago. However, some paleontologists think that simple, tiny animals may have existed much earlier, perhaps as early as 1 billion years ago.

The world of prehistoric animals

Most animals have developed during a time in the earth's history that scientists call the Phanerozoic Eon, which means "time of visible animal life." It began about 544 million years ago and continues to the present day. Scientists divide the Phanerozoic Eon into three *eras:* (1) the Paleozoic Era, which lasted from about 544 million to 248 million years ago; (2) the Mesozoic Era, which lasted from 248 million to 65 million years ago; and (3) the Cenozoic Era, which began 65 million years ago and continues today. Throughout each era, climates kept changing, continents drifted and changed in outline, mountains rose up and were leveled, and sea levels rose and fell. These changes helped determine which living things survived and which died out.

Each of the three eras is divided into shorter intervals called *periods.* Periods, in turn, can be divided into still shorter intervals called *epochs.* Different layers of rock with different kinds of fossils formed during each period. Such rocks help scientists understand how the earth's surface and climates have changed. The fossils tell paleontologists what animals and plants lived during each period.

Early forms of animal life

Animal life evolved and flourished only after plants became available as food. Like animals today, prehistoric animals depended on green plants. Green plants can use energy from sunlight to make food. Animals cannot do so. They must eat either plants or plant-eating animals.

Hans-Dieter Sues, the contributor of this article, is Senior Curator of Fossil Vertebrates at the Royal Ontario Museum.



Prehistoric animals included some of the most unusual creatures that ever lived. This fossil skeleton belonged to a giant ground sloth. This huge, plant-eating mammal was nearly as tall as a house, standing 14 $\frac{1}{2}$ feet (4.4 meters) tall on its hind legs.

The earliest animals lived in the seas and were probably tiny. Although their bodies were small, they were made up of many cells. Some groups of those cells became adapted for feeding or reproduction, while others helped the animals move and detect changes in their environment.

The first animals are known from fossils preserved in rocks about 600 million to 570 million years old. They include jellyfishes, worms, and leaflike creatures called *sea pens.* All these creatures were *invertebrates*—that is, they had no backbones. Their soft bodies also lacked shells or other hard parts. As a result, few of them were preserved as fossils.

According to fossils found by scientists, animals first become abundant at the beginning of the Paleozoic Era. A tremendous variety of invertebrate animals suddenly developed in the oceans during this time. Unlike earlier animals, many of these creatures had hard shells or tough outer frames to protect them from enemies.

Trilobites ranked among the most common early Paleozoic animals. They were ancient *arthropods,* the group to which spiders and crabs belong. Most trilobites fed on small food particles from the sand or mud on which they lived. Such food may have included small worms and other bottom-dwelling animals. Another common group of Paleozoic animals, the *brachiopods,* had shells

similar to those of clams. They lived on the sea floor or burrowed in the mud. Brachiopods ate tiny organisms. They fed by opening their shells and filtering food from the water with a comblike organ.

The first animals with backbones, called *vertebrates,* probably appeared at the end of the Cambrian Period, more than 500 million years ago. The earliest vertebrates were small. Plates of bone usually protected their heads and much of their bodies. In later vertebrates, a skeleton made up of many bones formed inside the body. The skeleton provided a solid internal frame to which muscles could attach.

The earliest vertebrates had mouths without jaws. They most likely fed on small bits of dead animals or tiny creatures on the sea floor or in the water. In the Silurian Period, beginning 440 million years ago, vertebrates developed bony jaws and teeth. These mouth parts enabled them to catch and consume larger kinds of food. The vertebrates also developed movable paired fins, enabling them to become more active swimmers.

The Devonian Period, often called the *Age of Fishes,* began about 410 million years ago. One of the largest Devonian fishes, *Dunkleosteus (DUHNK uhl AHS tee uhs),* grew 23 feet (7 meters) long. Massive plates of bone protected *Dunkleosteus's* head and the front of its body. Its jawbones formed sharp edges for cutting up and eating smaller fish.

Bony fishes of the Devonian Period had two types of fins, *rayed* and *lobed.* Rayed fins consist of a web of skin supported by a skeleton of rods called rays. Fish with this type of fin, known as *ray-finned fishes,* are fast swimmers. Lobed fins consist of a fleshy stalk fringed with rays. The Devonian Period was the time of greatest abundance for fishes with this type of fin, called *lobe-finned fishes.* Lobed fins enabled the creatures to crawl along the bottom of the sea or over land. Many lobe-finned fishes also had lungs with which they gulped air when there was not enough oxygen in the water. All land-living vertebrates, including human beings, descended from these fishes.

The move onto land. Animals first established themselves on dry land by the beginning of the Devonian Period. The oldest known land animals were arthropods, including scorpions, spiders, and mites. Vertebrates probably first moved onto land near the end of the Devonian Period. The sturdy fins of lobe-finned fishes evolved into the legs of land-living vertebrates, with ankles, wrists, fingers, and toes suitable for leaving the water. Lungs became full-time suppliers of oxygen.

Four-footed land vertebrates are known as *tetrapods (TEHT ruh pahdz).* The first tetrapods, called *amphibians,* had to return to the water to lay eggs. These eggs were enclosed in a jellylike substance that, if left on land, would dry out and kill the eggs. Thus amphibian eggs developed and hatched in water, where the young lived until they changed into land-dwelling, air-breathing adults. During the late Paleozoic Era, a great variety of amphibians inhabited the shores of lakes and rivers, dividing their lives between land and water. Modern amphibians, including frogs and toads, are small, but some Paleozoic amphibians were large. The meat-eating *Eryops (UR ee ahps)* grew more than 5 feet (1.5 meters) long and had a big head. Others, such as *Ophiderpeton (oh fee DURP uh tahn),* were small and snakelike.

The earliest insects were wingless and appeared during the Devonian Period. By the late Carboniferous Period, about 300 million years ago, many insects had developed wings. They included *Meganeura (mehg uh NYUR uh),* a spectacular animal resembling a dragonfly. It had a wingspan of up to 26 inches (65 centimeters).

The first reptiles evolved from amphibians during the Carboniferous Period. Reptiles had an important advantage over earlier land-living vertebrates: they could lay their eggs on land. Reptile eggs were protected by a hard leathery shell that prevented them from drying out. Special membranes inside the eggs enclosed and protected the developing young in a fluid-filled chamber. This type of egg enabled reptiles to live entirely on land.

The Age of Reptiles

During the Permian Period at the end of the Paleozoic Era, the earth's climate generally grew warmer and drier. Deserts spread over large areas, displacing many amphibians that needed water for their survival. At the end of the period, about 248 million years ago, the seas shrunk as sea levels dropped severely worldwide. This lowering of the sea level helped cause one of the earth's largest known extinctions. Ninety-five percent of species may have perished in the seas at that time. But reptiles survived the new conditions on land and sea. Thus these animals came to dominate the earth throughout most of the Mesozoic Era, which lasted from about 248 million years ago to about 65 million years ago. This era is often called the *Age of Reptiles.*

Dinosaurs ranked as the dominant reptiles of the Mesozoic. They varied greatly in size, including some of the largest animals that ever lived. The longest was the plant-eating *Seismosaurus,* which may have measured about 150 feet (45 meters) in length. The smallest fully grown dinosaurs grew to about 3 feet (1 meter) in length. Many large dinosaurs were probably slow-moving. But scientists believe some dinosaurs, such as *Ornithomimus (awr NIH thuh MY muhs),* could run fairly fast. For more information about dinosaurs, see **Dinosaur.**

Other reptiles. While dinosaurs ruled the land, many kinds of large reptiles inhabited the sea and air. Sea-dwelling reptiles included *ichthyosaurs (IHK thee uh sawrs),* which resembled dolphins in shape and probably could swim fast. *Mosasaurs (MOH suh sawrs)* were enormous sea lizards that lived during the late Cretaceous Period, which ended about 65 million years ago. They grew up to 30 feet (9 meters) long. *Plesiosaurs (PLEE see uh sawrs)* had four large flippers and a short tail. Many plesiosaurs also had an extremely long neck.

Flying reptiles called *pterosaurs (TEHR uh sawrz)* became the first vertebrates to evolve flapping flight, the kind of flight later used by most birds. Each of a pterosaur's wings consisted of a membrane of skin supported by a long finger made of hollow bones. Pterosaurs had no feathers, but hairlike structures probably covered their bodies. Some pterosaurs ranked as the largest flying animals of all time, reaching a wingspan of 40 feet (12 meters).

Invertebrates flourished during the Age of Reptiles, and many new kinds appeared. Numerous species of mollusks lived in the seas. They included clams, snails, squids, and *ammonites,* which formed spiral-shaped shells. *Crustaceans,* including lobsters, crabs, and

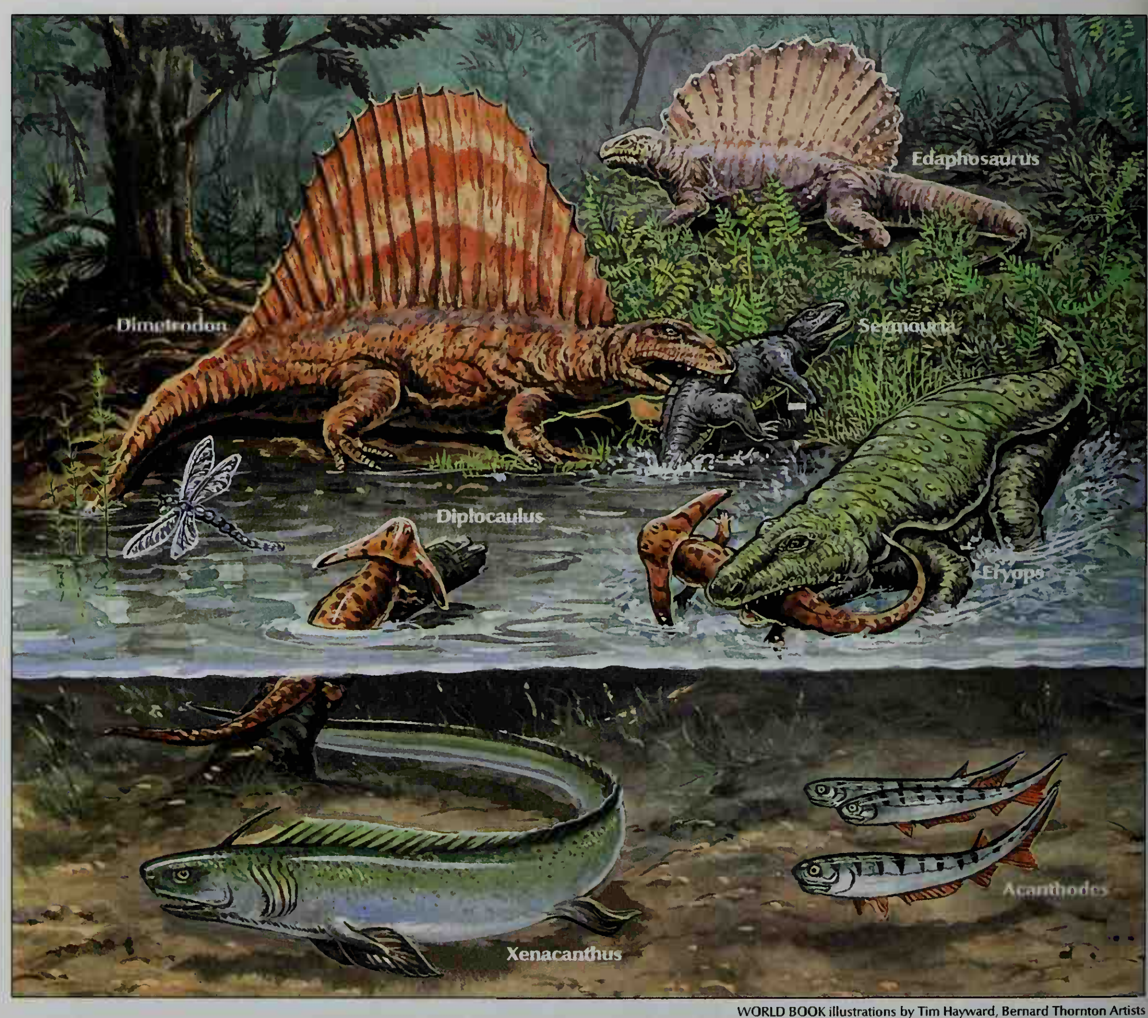
shrimp, became common in the oceans during the Cretaceous Period. All major present-day groups of insects had evolved by Cretaceous times.

Fish remained abundant in the Mesozoic Era. The first modern kinds of bony fish, called *teleosteans (TEHL ee AHS tee uhnz* or *TEE lee AHS tee uhnz)*, evolved near the end of the Triassic Period, about 213 million years ago.

Amphibians. Many of the larger amphibians had died out by the end of the Triassic Period. But some kinds persisted well into the Cretaceous Period. Smaller amphibians, including frogs and salamanders, first appeared at the beginning of the Jurassic Period, around 213 million years ago.

Birds evolved from small meat-eating dinosaurs during the Jurassic Period. The oldest known bird, *Archaeopteryx (AHR kee AHP tuhr ihks)*, lived around 145 million years ago. It grew to about the size of a crow. *Archaeopteryx* was covered with feathers, but it resembled reptiles in many features. It had teeth, a long tail, and three grasping, clawed fingers on each wing.

Period	Cambrian	Ordovician	Silurian	Devonian	Carboniferous	Permian
Began	544 million years ago	505 million years ago	440 million years ago	410 million years ago	360 million years ago	286 million years ago
Lasted	39 million years	65 million years	30 million years	50 million years	74 million years	38 million years
Animal life	Trilobites were common in the sea. Jawless fish appeared. Land was bare.	Mollusks and coral were plentiful in the sea. Algae became common.	Fish developed jaws. Plants appeared on land.	Fish were plentiful. Insects and amphibians appeared.	Crustaceans, fish, and amphibians were plentiful. Reptiles appeared. Huge, swampy forests grew. Giant insects lived in the forests.	Seed plants appeared. Trilobites died out near the period's end.



WORLD BOOK illustrations by Tim Hayward, Bernard Thornton Artists

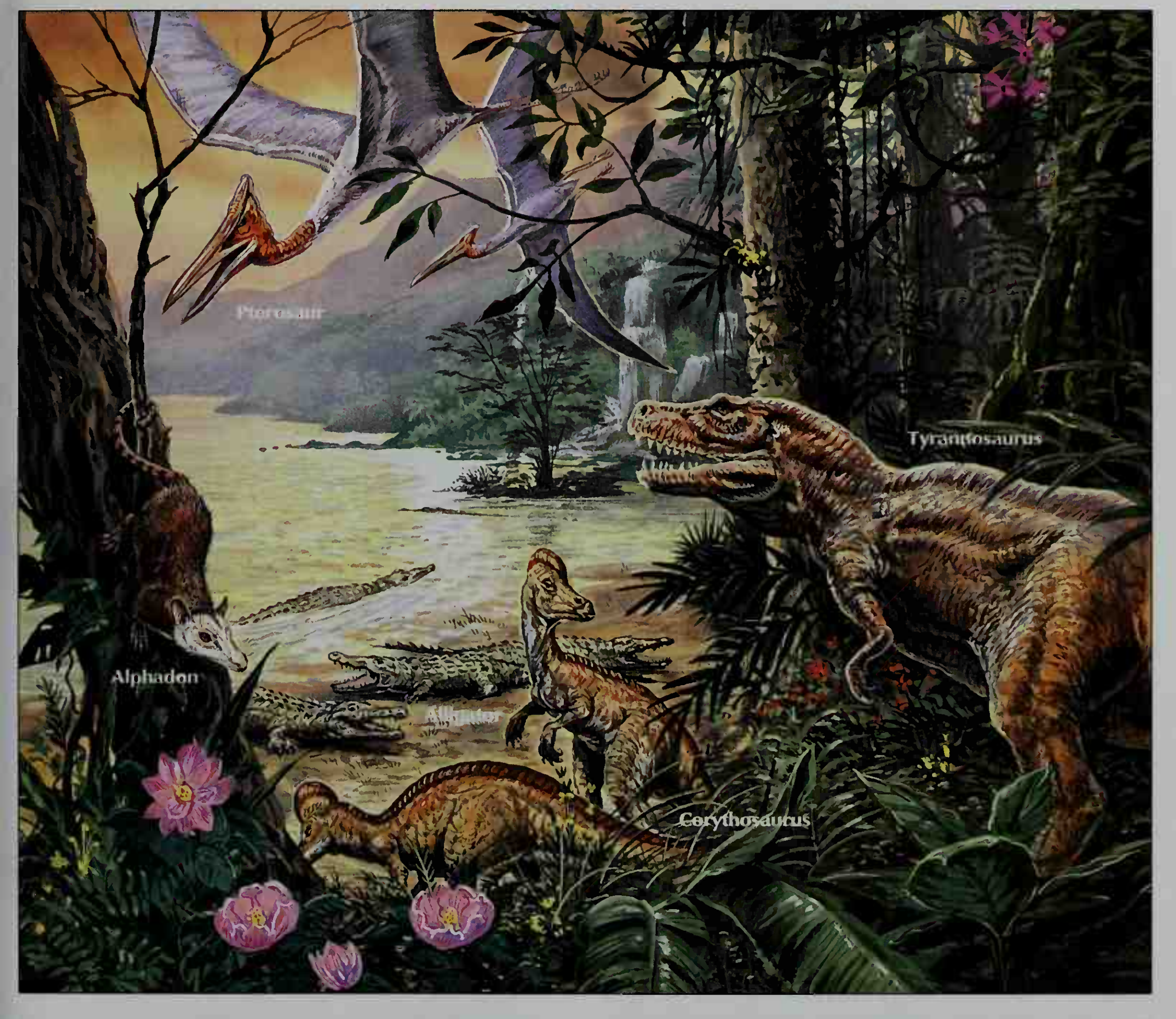
Animal life of the Paleozoic Era included an abundance of species. Animals from the Permian Period at the end of that era, *shown here*, included *Dimetrodon* and *Edaphosaurus*, which had large saillike fins on their backs. Such amphibians as the large *Eryops*, triangular-headed *Diplocaulus*, and smaller *Seymouria* lived on land and sea. Large insects and fish were also common.

The first modern birds appeared in the Cretaceous Period. They developed a toothless beak covered by hornlike material. The tail became short, and the fingers fused into a single structure supporting the wing.

Mammals evolved from mammallike reptiles near the close of the Triassic Period. The first mammals were small, about 6 inches (15 centimeters) long, and probably ate insects and other small animals. These mammals likely had hair covering their bodies. Like their modern descendants, ancient mammals suckled their young from special milk glands. Most Mesozoic mammals probably laid eggs as their reptile ancestors had done. Today, the only egg-laying mammals, called *monotremes,* are the duck-billed platypus and the echidnas of Australia and New Guinea.

The two major groups of mammals, *marsupials* and *placentals,* first developed in the Cretaceous Period. Both these groups give birth to live young. Marsupial young are born in an underdeveloped state. The young crawl into a special pouch on the mother's belly, where

Period	Triassic	Jurassic	Cretaceous
Began	248 million years ago	213 million years ago	145 million years ago
Lasted	35 million years	68 million years	80 million years
Animal life	The first turtles, crocodiles, dinosaurs, sea reptiles, flying reptiles, and mammals appeared. The huge supercontinent began to break up into separate continents.	The first birds appeared. Dinosaurs reached their greatest size. Insects were plentiful. Ammonites flourished in the sea. A few small mammals lived on land.	Horned and armored dinosaurs became common. Flowering plants developed. Dinosaurs, flying reptiles, and giant sea reptiles died out at the end of the period.



Reptiles dominated the Mesozoic Era, ruling the land, sky, and sea. The illustration above shows animals from the Cretaceous Period. They include the huge meat-eating dinosaur *Tyrannosaurus* and the plant-eating duckbilled dinosaur *Corythosaurus.* Other reptiles besides dinosaurs included flying pterosaurs and early aquatic alligators. Early mammals ,such as *Alphadon,* also lived during this time.

they continue to develop and grow. Most early marsupials resembled modern opossums.

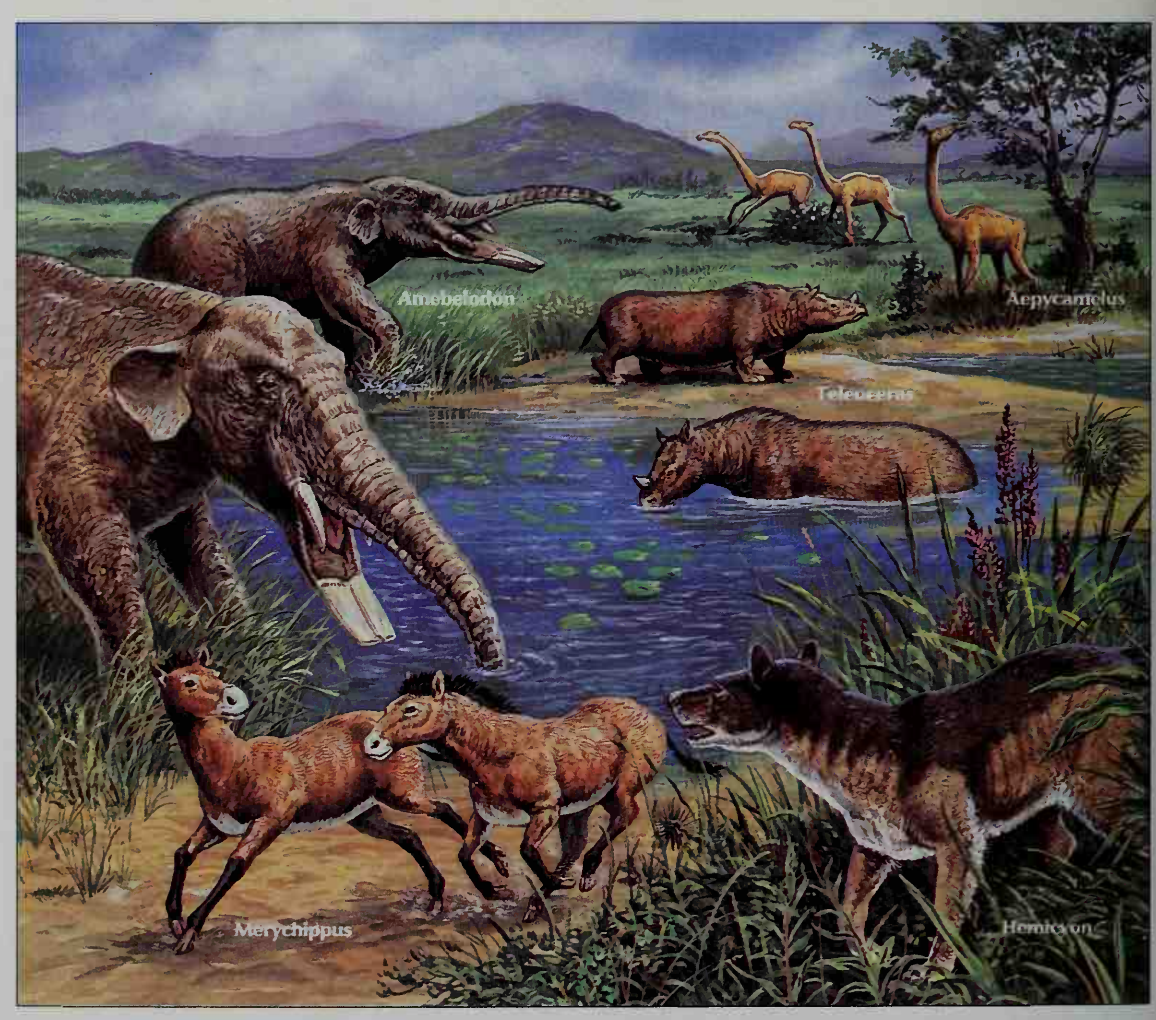
Placentals give birth to fairly well-developed young. These young grow inside the mother's body, where they receive nourishment from a special organ called the *placenta.* Many early placentals resembled shrews.

The Age of Mammals

By the end of the Mesozoic Era, some 65 million years ago, dinosaurs and other dominant reptiles had become extinct. Scientists have found evidence that a huge asteroid hit the earth about 65 million years ago. Dust from the impact of this asteroid, as well as soot from the wildfires caused by the impact, would have blocked sunlight from reaching the earth's surface. Lack of sunlight would have lowered temperatures worldwide and killed many of the plants and animals that dinosaurs ate.

The Cenozoic Era, also called the *Age of Mammals,* followed the Mesozoic Era and continues today. During this new era the climate grew gradually cooler and drier,

Period	Tertiary					Quaternary	
Epoch	**Paleocene**	**Eocene**	**Oligocene**	**Miocene**	**Pliocene**	**Pleistocene**	**Holocene**
Began	65 million years ago	56 million years ago	34 million years ago	24 million years ago	5 million years ago	2 million years ago	11,500 years ago
Lasted	9 million years	22 million years	10 million years	19 million years	3 million years	2 million years	11,500 years
Animal life	The kinds of mammals expanded rapidly.	First camels, horses, and other mammals appeared.	Grassland spread. Primitive apes appeared.	Mammals reached their greatest variety.	Humanlike creatures and many modern mammals appeared.	Modern human beings developed. Ice ages occurred.	Human beings hunted and tamed many animals.



Mammals ruled the earth during the Cenozoic Era. This illustration shows mammals that lived in the Miocene Epoch. Some of them resembled their present-day relatives, such as the elephantlike *Amebelodon,* the early rhinoceros *Teleoceras,* and the ancient horse *Merychippus.* Others resembled modern mammals that are not close relatives. The doglike *Hemicyon* was actually an early bear.

and mammals became the dominant animals on the earth. All mammals have warm-blooded bodies covered with hair and are equipped with a variety of teeth for chewing food. Warm-bloodedness, which keeps the mammals' bodies at constant high temperatures, probably enabled early mammals to adapt more easily than other vertebrates to the cooler, drier climates of the Cenozoic Era.

The development of placentals. Most of the world's modern placentals probably evolved at the beginning of the Cenozoic Era. These creatures had small bodies. For example, *Miacis (MY ah sihs),* a forerunner of all meat-eating mammals, grew about as large as a weasel. The ancient horse *Hyracotherium (HY ruh koh THEER ee uhm),* also called *Eohippus (EE oh HIHP uhs),* stood no taller than a dog. Primates started out as small creatures but later evolved into monkeys, apes, and human beings. One of the earliest whales, *Pakicetus (pak ee SEE tuhs),* grew only about 6 feet (1.8 meters) long. Its descendants, however, became some of the earth's largest animals.

By the middle of the Cenozoic Era, many forests had disappeared. Grasslands spread across many parts of the world, and climates grew cooler and drier. Such hoofed mammals as deer and horses developed teeth suitable for feeding on grass. Many hoofed mammals also had long, slender legs, enabling them to run fast to escape from predators in open country.

The great increase in plant-eating mammals provided abundant prey for meat-eating mammals. These meat-eaters included the earliest dogs and the saber-toothed cats, large lionlike predators that could kill their prey with huge fanglike teeth. In Africa and Asia, the first apes evolved. Many new species of rodents appeared, and they quickly became the most common small mammals.

The distribution of mammals. About 250 million years ago, all the continents drifted together to form one huge land mass, the supercontinent *Pangaea.* Around 200 million years ago, Pangaea began to break up again into separate continents, which slowly moved to their present positions.

Placental and marsupial mammals may have developed on the northern continents. When Australia separated from South America and Antarctica at the beginning of the Cenozoic, many marsupials and probably only a few placentals had spread there. With few placentals to compete with for food and nesting sites, many kinds of marsupials evolved only in Australia. Some marsupials resembled placental mammals in appearance and habits. They included *Diprotodon (dy PROH tuh dahn),* which resembled a hippopotamus, and the doglike Tasmanian wolf. *Procoptodon (proh KAHP tuh dahn)* and other early kangaroos developed a plant-eating way of life similar to that of hoofed placentals.

Both marsupials and placental mammals spread to South America during the Cretaceous Period. But at the end of that period, South America became separated from the rest of the world for about 60 million years. As a result, many unique kinds of mammals developed on that continent. Prehistoric South American marsupials included the *Thylacosmilus (THY luh koh SMY luhs),* a predator that looked like a saber-toothed cat, and *Borhyaena (bor hy EE nuh),* which resembled a wolf. Placental mammals in South America included armadillos and huge ground sloths.

About 3 million years ago, a land connection formed between North and South America. Many North American mammals moved to South America, causing the extinction of numerous South American marsupials and placentals. But some South American mammals migrated in the opposite direction and settled in North America. These included the opossum, a marsupial, and the porcupine, a placental.

The development of other animals. All major groups of modern amphibians and reptiles had evolved by the Cretaceous Period and survived the great extinction 65 million years ago. Among reptiles, lizards and snakes became common. Many birds developed during the Cenozoic Era. They included the flightless *Diatryma (DY uh TRY muh),* which grew about 7 feet (2 meters) tall.

The ice ages. A few million years ago, the climate grew colder on the northern continents. This led to a series of ice ages during the Pleistocene Epoch, which occurred about 2 million to 11,500 years ago. During these ice ages, glaciers repeatedly spread and retreated over large areas of North America, Europe, and Asia. One of the most prominent mammals of this period, the elephantlike mammoth, roamed the frozen plains of the Northern Hemisphere. Its thick coat of dense, long hair helped keep it warm.

Many large placental mammals died out before the last glaciers retreated about 11,500 years ago. In North America, these included giant ground sloths, saber-toothed cats, and mammoths. Some scientists believe many large mammals were hunted to extinction by prehistoric people, but others argue that the animals disappeared because of changes in climate and plant life.

Prehistoric human beings lived only a short part of the earth's long history. Most scientists now think that prehistoric people evolved from humanlike apes between about 10 million and 5 million years ago.

The study of prehistoric animals

Interpreting fossil evidence. Fossils provide paleontologists with a record of prehistoric animals and plants and the environments in which they lived. On rare occasions, entire prehistoric creatures are preserved as fossils. Most fossils, however, consist of such hard body parts as shells, bones, and teeth.

Paleontologists must compare fossils with animals that live today to learn about prehistoric creatures. For example, scientists can estimate an ancient mammal's size and weight by comparing the shape and size of its leg bones with leg bones of related modern mammals. Fossils also reveal information about an animal's way of life. Prehistoric animals with long legs probably were fast runners, just like animals with long legs today, whereas animals with short, stout legs moved more slowly. By measuring the distance between a dinosaur's fossilized footprints, paleontologists can calculate how fast the animal moved. The shape of fossil teeth can show what type of food a prehistoric animal ate. The teeth of meat-eaters have sharp edges for cutting and slicing through meat, while plant-eaters often have broad, blunt teeth for grinding plant material, which may include tough fibers.

Fossils show that many prehistoric animals have de-



Natural Science Photos

The study of fossils enables scientists to learn about prehistoric animals. Before removing bones from the ground, the scientist above dusts them off and numbers them in order. Eventually, the bones are taken to a laboratory where they are studied.

scendants that still exist today. Birds are the closest living relatives of dinosaurs. Bird skeletons resemble the skeletons of meat-eating dinosaurs more closely than they resemble those of any living animal.

Evolution and extinction. According to the *theory of evolution,* organisms adapt to changes in their environment by developing new characteristics. These characteristics increase their chance to survive and flourish under the changed conditions. The study of fossils provides important evidence for evolution. Fossils show that living beings usually have developed from simpler organisms throughout the earth's long history.

Much evolutionary change is gradual, producing a kind of extinction called *background extinction.* In background extinction, old species slowly die out as new ones evolve. But during a *mass extinction,* many different kinds of plants and animals suddenly die out. The most famous mass extinction occurred at the end of the Cretaceous Period, when dinosaurs and countless other living things disappeared.

Some paleontologists believe a collision of an asteroid with the earth caused each mass extinction. But according to other scientists, this theory may not explain why many animals survived such events. They think an overall change in the earth's climate caused most large extinctions. A general rise or fall in temperature or a change in the amount of rainfall could create conditions in which some species die off and others adapt and survive. Extinctions may also result after animals move across a newly formed land bridge into a new area. The newcomers may compete successfully for food with animals already living there, thus killing off the native species.

By studying why prehistoric extinctions occur, scientists may learn more about why species are disappearing today. Up to 99.9 percent of all animal species that have ever existed are now extinct.

Hans-Dieter Sues

Related articles in *World Book.* See Dinosaur with its list of *Related articles.* See also the following articles:

Prehistoric animals

Archaeopteryx
Coelacanth
Ground sloth
Hesperornis
Mammoth
Mastodon
Pterosaur
Saber-toothed cat
Trilobite

Other related articles

Amphibian (The history of amphibians)
Bird (The development of birds)
Dog (History)
Earth (History of Earth)
Evolution (The fossil record)
Extinct animal (Prehistoric extinctions)
Fish (The development of fish)
Fossil
Horse (Origins of the horse)
Ice age
Mammal (The evolution of mammals)
Paleontology
Plant (Early plants)
Pleistocene Epoch
Prehistoric people
Reptile (The evolution of reptiles)

Outline

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  B. Evolution and extinction

Questions

Which animals evolved into the first land-living vertebrates?
Why did many marsupials develop in Australia?
Why did the earliest invertebrates leave few fossils?
What were some giant prehistoric reptiles besides dinosaurs?
What scientific theories explain why mass extinctions occurred?
Why did mammals come to dominate the Cenozoic Era?
What animals flourished during the Devonian Period?
From what prehistoric animals did birds evolve?
How do fossils help scientists learn about prehistoric animals?
How big was the first horse?

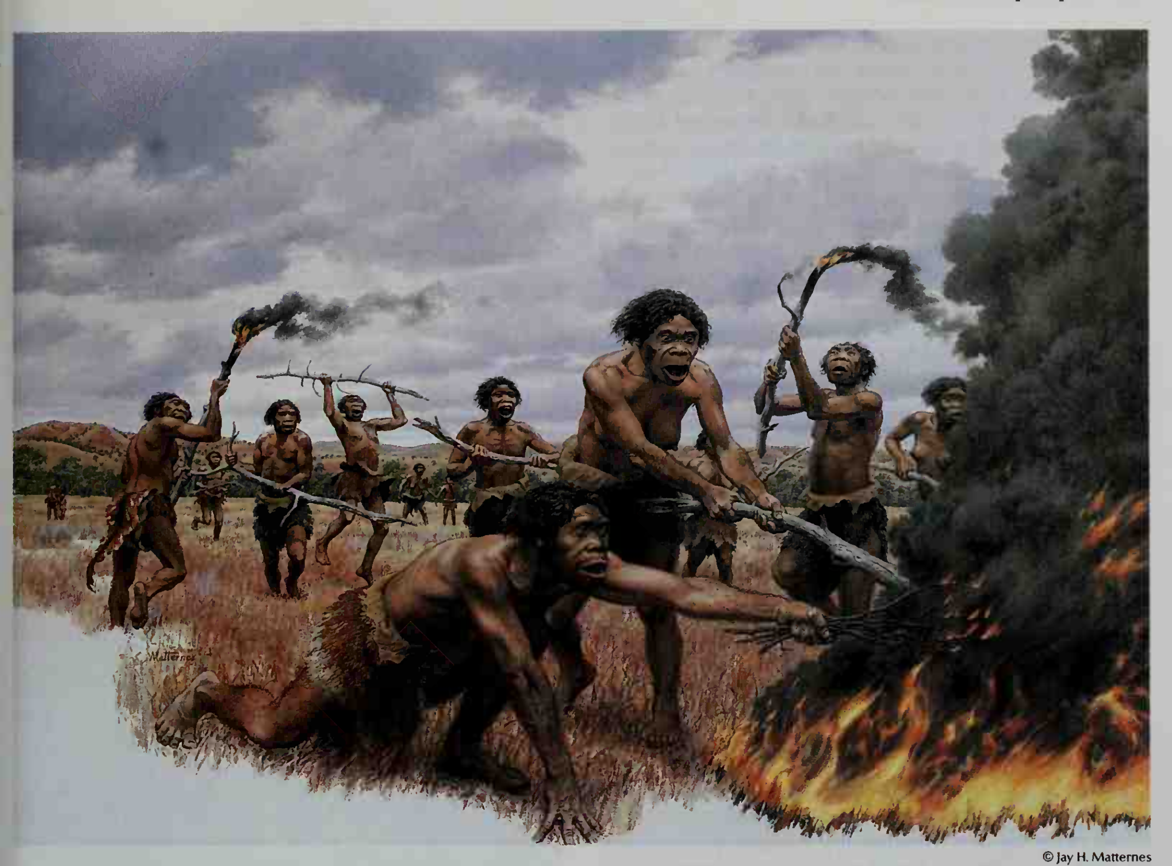
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Level II

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Prehistoric people are the ancestors of modern human beings. This illustration is an artist's idea of how one type of prehistoric people, *Homo erectus,* may have learned to use fire. Cultural advances, such as the use of fire and clothing, helped *Homo erectus* spread to much of the world.

Prehistoric people

Prehistoric people are human beings who lived before writing was invented about 5,500 years ago. Writing enabled people to record information they wished to save, including descriptions of events in their lives. In this way, the invention of writing marked the beginning of history. The period before human beings learned to write is called *prehistory,* and people who lived during this period are known as *prehistoric people.*

Most scientists believe the first human beings lived about 2 million years ago. But early people probably arose from prehuman ancestors who first lived over 4 million years ago. These ancestors were small, humanlike creatures who walked erect. This article will discuss both prehistoric people and their near ancestors.

Scientists first discovered evidence of prehistoric people during the mid-1800's. Most of this evidence consisted of ancient, sharp-edged tools that prehistoric people had made of stone. The first fossilized bones of prehistoric people were also found during this time.

As scientists collected fossils of prehistoric people, they began to form a clearer picture of what early people looked like. For example, scientists learned from fossil evidence that early human beings had smaller brains than most modern people have. This evidence indicated to many scientists that human beings had *evolved*—that is, modified their physical structure over time. Scientists formed a set of ideas about human origins called the theory of human evolution. This theory states that as the environment of the prehistoric world changed, the prehuman ancestors of prehistoric people underwent a series of changes that resulted in the first human beings. They, in turn, evolved into modern human beings.

Today, many kinds of scientists work together to learn about prehistoric people. Physical anthropologists examine the fossilized bones and teeth of prehistoric people and their prehuman forerunners. They study these objects to learn more about what our ancestors looked like, how long they lived, and what foods they ate. Archaeologists search for and examine evidence, such as pottery and tools, to help explain how prehistoric people lived. Botanists study the remains of prehistoric plants, and zoologists analyze fossils of animals that lived when prehistoric people did. Geologists study the rock in which fossils are found. All these scientists are

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called anthropologists if their chief concern is the study of human physical and cultural development.

Evidence of prehistoric people—such as fossils, tools, and other remains—is rare and often fragmented. Evidence of the earliest types of prehistoric people is the most difficult to find. Anthropologists must base their theories on this extremely limited evidence. As a result, scientists cannot yet present a detailed picture of early human life. In addition, new discoveries sometimes disprove theories that scientists already hold. For example, in 2000 and 2001, scientists in Kenya announced the discovery of fossil bones from two new humanlike species, *Orrorin tugenensis* and *Kenyanthropus platyops.* In 2002 in Chad, a fossil from another humanlike species was discovered. This fossil, from the new species *Sahelanthropus tchadensis,* is about 7 million years old. Scientists are studying these fossils to determine how these new species are related to other human ancestors.

Prehuman ancestors

Most scientists believe that human beings and apes—such as chimpanzees and gorillas—share a common ancestor. To support this theory, scientists point out that the fossilized remains of ancient humanlike beings and apes reveal many similarities, including similar brain sizes. In addition, studies comparing the physical structure, blood, and genetic material of modern human beings with those of apes show that people are more similar to apes than to any other living animal.

The ancestors of human beings probably began evolving separately from the ancestors of apes between about 10 million and 5 million years ago. This evolutionary split marks the beginning of the development of *hominids.* Hominids make up the scientific family that consists of human beings and early humanlike ancestors.

Where and when they lived. The earliest known hominids were a species called *Ardipithecus ramidus.* The name *Ardipithecus* comes from words in the Afar and Greek languages that mean *ground ape.* These creatures lived in Ethiopia in northeast Africa about 4,400,000 years ago. Scientists know little about them except that, like all hominids, they stood and walked on two legs.



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Footprints of a prehuman ancestor were found at Laetoli, in Tanzania. These footprints, which were fossilized in volcanic ash, provide evidence that early hominids walked upright.

A much better-known group of early hominids are the *australopithecines* (pronounced *aw stray loh PIHTH uh seenz).* They first appeared about 4 million years ago in Africa. Fossil evidence suggests that these creatures became extinct between 2 million and 1 million years ago, about when the first human beings appeared.

Scientists have found australopithecine fossils in eastern, southern, and north central Africa. Most scientists believe that hominids originated in Africa and that prehistoric people later spread to other parts of the world.

What they looked like. The australopithecines looked much different from modern human beings. In some ways, such as in their facial features, they may have resembled chimpanzees. But they could stand upright and walk on two legs, and their canine teeth were much smaller and less pointed than those of apes.

The australopithecines had large faces that jutted out. Their brains were about one-third the size of modern human brains. Their molars were large, flat, and suitable for grinding food. Anthropologists believe from the shape of these creatures' teeth and from chemical analysis of their bones that they ate such foods as fruits, vegetables, nuts, seeds, insects, and small animals.

Types of australopithecines. The australopithecines belonged to the genus *Australopithecus,* a term that means *southern ape.* Most scientists have divided the genus into at least five species based on differences in the creatures' overall size, in the shape and size of their jaws and teeth, and in the size of their brains. The five species are (1) *A. anamensis,* (2) *A. afarensis,* (3) *A. africanus,* (4) *A. boisei,* and (5) *A. robustus.*

The earliest known species of *Australopithecus* was *A. anamensis,* which appeared in eastern Africa around 4 million years ago. Another *Australopithecus* species, *A. afarensis,* appeared about 3,700,000 years ago. One of the most complete australopithecines that scientists have found is a partial skeleton of a female *A. afarensis.* It was found at Hadar, Ethiopia. Scientists estimate that this creature, nicknamed "Lucy," was a little more than 3 feet (90 centimeters) tall and weighed about 60 pounds (27 kilograms). Scientists also have discovered the fossilized footprints of three *A. afarensis* individuals at Laetoli, in Tanzania. The footprints resemble those of modern people and show that *A. afarensis* walked as we do, fully supported by two legs. *A. afarensis* had about the same size brain that a chimpanzee has.

By about 3 million years ago, another australopithecine, *A. africanus,* was living in southern Africa. These creatures had rounder skulls and slightly larger brains than those of *A. afarensis.* In 1998, a complete *A. africanus* skeleton was discovered at Sterkfontein, a fossil site near Johannesburg, in South Africa.

During the time of *A. africanus,* two more australopithecine species appeared. One of them, *A. boisei,* lived in eastern Africa. The other, *A. robustus,* lived in southern Africa. Scientists call these two species the *robust* australopithecines. They had larger molars and more powerful jaws than the other three *Australopithe-*



Institute of Human Origins

The skeleton of "Lucy," a prehuman ancestor, is one of the most complete australopithecine fossils that scientists have found. This creature lived about 3 million years ago.

cus species, and may have had larger bodies. But their brain size was about the same as that of *A. africanus.* The earlier three species are called *gracile* (slender) australopithecines. The robust species probably became extinct between 1 $\frac{1}{2}$ million and 1 million years ago.

Scientists are uncertain about the precise relationships between the *Australopithecus* species. Some think the gracile species evolved one after the other, from the earliest, *A. anamensis,* to the latest, *A. africanus.* According to this theory, the two robust species formed an evolutionary side branch. Other scientists think the australopithecine species were linked differently. They believe that early in australopithecine evolution, these creatures spread to different parts of Africa, changing to adapt to their new environments. As a result, different species developed in different environments.

The first human beings

Most anthropologists believe the first people evolved from an australopithecine about 2 million years ago. The oldest tools scientists have found date from about that time. But because no hominid fossils were found with these tools, scientists do not know whether an australopithecine or an early human being made them.

Most prehistoric tools that have been found are made of stone. Thus, this period is called the Stone Age. Early toolmakers may also have used wood and other materials, but no tools made of those materials have survived. The Stone Age lasted from the first use of stone tools until bronze replaced stone as the chief toolmaking material. In some areas, this occurred about 3000 B.C.

The first part of the Stone Age is called the Paleolithic Period. It began over 2 million years ago and lasted until about 8000 B.C., when some people in the Middle East began farming. Even after these people learned to farm, many others continued to live by gathering wild plants and by hunting. These Stone Age hunters and gatherers who lived after 8000 B.C. are called *Mesolithic* people. Farmers from this period are called *Neolithic* people.

Three species. The first human beings lived in Africa about 2 million years ago. Anthropologists have found important fossils of these people near the shores of Lake Turkana in Kenya and in Olduvai Gorge in Tanzania. Many scientists divide these people into three species—*Homo habilis, Homo rudolfensis,* and *Homo erectus.*

Homo habilis had a brain larger than an australopithecine brain but only about half the size of a modern human brain. *Homo habilis* also had smaller molars and a less protruding face than the australopithecines had. The Latin word *Homo* means *human being. Habilis* means *handy* or *skillful. H. rudolfensis* had a brain larger than that of *H. habilis.* It also had large molars, like those of the australopithecines. The name *rudolfensis* comes from Lake Rudolph, an old name for Lake Turkana. Fossils of *H. rudolfensis* have been discovered near the lake.

Some anthropologists are uncertain whether *H. habilis* and *H. rudolfensis* were two different species or whether they represent, respectively, the females and males of one species. Such a difference in size between the sexes is known as *sexual dimorphism.* This type of difference appears among many modern apes and was present among the australopithecines. Sexual dimorphism is less extreme in modern human beings.

Another species of early human being, *Homo erectus,* lived at the same time as *H. habilis* and *H. rudolfensis.* The term *erectus* refers to the upright posture of these creatures. Most scientists believe *H. erectus* was the species that evolved into modern people.

Homo erectus had a brain slightly larger than that of *H. rudolfensis,* but it also had smaller back molars. During the course of *H. erectus* evolution, brain size increased, eventually reaching a size just slightly smaller than that of a modern human brain. *Homo erectus* individuals had thick skulls, sloping foreheads, and large, chinless jaws. Their skulls had a *browridge,* a raised strip of bone across the lower forehead. *H. erectus* also had a smaller and less protruding face than *H. habilis* and *H. rudolfensis* had. Fossils indicate that the *Homo erectus* males were larger than the females.

The earliest *Homo erectus* fossils have been found in Africa. They date from more than 1,750,000 years ago. One of the best-known examples of *H. erectus* is a nearly complete fossil skeleton of a boy who was probably about 11 or 12 years old when he died. The skeleton, which is over 1,500,000 years old, was found near Lake Turkana. The boy had already reached 5 feet 3 inches (160 centimeters) in height and might have grown to 6 feet 1 inch (185 centimeters) if he had lived to adulthood.

Members of *H. erectus* eventually migrated from Africa to Asia and Europe. The species reached the is-

land of Java, in Indonesia, by 1,200,000 years ago, and perhaps as early as 1,600,000 years ago. *H. erectus* reached Europe more than 700,000 years ago. By 600,000 years ago, the species had spread into northern Asia.

How they lived. Many anthropologists believe that *H. habilis, H. rudolfensis,* or *H. erectus* made the first stone tools. The earliest tools were sharp-edged stones used for cutting, scraping, and chopping. Prehistoric people made them by striking one stone with another, chipping pieces away to produce a cutting edge. The first tools were crude, but over time early human beings began to craft tools of a finer quality. Later toolmakers used mallets of wood or bone to tap away small chips of stone, producing a straight, sharp cutting edge.

Scientists believe the early human beings ate meat in addition to fruits, insects, and plants. Archaeologists have found animal bones buried with stone tools from the time of the first people. Some of the bones show scratch marks that were probably made by the cutting action of stone tools. These marks indicate that the early butchers used tools to cut up game and to scrape meat off bones. But scientists do not know whether these early people killed large animals themselves or merely ate the meat after the animals had been killed by predators.

During the time of *Homo erectus,* tools became more skillfully made, and new tool types appeared. For example, *H. erectus* made double-edged cutting tools called *hand axes* out of stone. Workers probably held these axes in their hands and used them without a handle for many tasks, such as shaping wood or bone and cutting up meat. *H. erectus* may have hunted large animals.

Homo erectus was probably the first human being to master the use of fire. These people may also have been the first to wear clothing. Scientists believe that as *H. erectus* moved into northern areas and faced cold winters, fire and clothing became necessary. Archaeologists have not found any traces of early clothing, but it was probably made from animal hides. The oldest evidence of the use of fire was found in a cave that *H. erectus* occupied about 600,000 years ago near what is now Beijing, in northern China. Stone tools and the remains of more than 40 *H. erectus* individuals were found in the cave, along with burnt animal bones.

The development of *Homo sapiens*

Scientists classify today's people as *Homo sapiens,* a term that means *wise human being.* Anthropologists disagree about the precise evolutionary relationships between *Homo sapiens* and earlier peoples. They also disagree about where and when *H. sapiens* first appeared.

Compared with the earliest human beings, people today have a high forehead and a higher and more rounded skull. They lack the browridge of earlier people and have a chin and a smaller, less-protruding face.

The origin of *Homo sapiens* is related to the origin of human races. Anthropologists today reject the idea that human beings can be divided into biologically defined races. Only slight differences distinguish the features of any two modern peoples who developed in neighboring regions. Thus, it is hard to draw a dividing line between them. But groups of people who have lived in certain parts of the world for many thousands of years tend to differ in appearance from groups in other parts of the world. These differences are probably adaptations to local environments. For example, people whose ancestors have lived for generations in sunny climates tend to have dark skin. Dark pigment helps protect the skin from sunburn and reduces the risk of skin cancer.

Anthropologists have developed two main theories to explain the origin of modern human beings and the development of what are sometimes called "races"—that is, the physical differences among populations in different regions. These theories may be referred to as (1) the multiple origins theory and (2) the single origin theory.

The multiple origins theory states that after *H. erectus* spread out of Africa, groups of these early human beings settled in different parts of Asia, and then, sometime after 1 million years ago, reached Europe. As they moved to new areas, with differing climates and plants and animals, these scattered populations developed different characteristics. In each geographical area, human groups with different appearances evolved. But because of the constant movement of individuals from one region to another, they continued to form a single species. Most anthropologists who support the multiple origins theory believe that between about 700,000 and 400,000 years ago, these scattered groups of *H. erectus* evolved into *H. sapiens.*

According to these scientists, the first *Homo sapiens* differed greatly from modern people, and in many ways strongly resembled *H. erectus.* The main difference between early *H. sapiens* and *H. erectus* was that early *H. sapiens* had a higher and more rounded skull. But like *Homo erectus,* the first *H. sapiens* individuals had large faces that protruded around the mouth and nose. They also had big browridges and low, sloping foreheads. These people lacked a chin, a feature found only in later *H. sapiens.* The brain size of early *H. sapiens* varied. Some of these people had brains that were similar in size to those of late *H. erectus.* Others had brains as large as modern human brains.

Neanderthals make up one of the groups that supporters of the multiple-origins theory classify as early *H. sapiens.* Neanderthals are the most widely known of the early human beings, mainly because their fossils were the first traces of prehistoric people ever discovered. The term *Neanderthal,* also spelled *Neandertal,* comes from the Neander Valley near Düsseldorf, Germany. The first Neanderthal fossils were found there in 1856.

Neanderthals lived in Europe, and eventually in the Middle East, between 130,000 and 30,000 years ago. They had features typical of early *H. sapiens,* including a protruding face, large browridge, and low forehead. Most Neanderthals also lacked a chin. But on the average, their brain was larger than that of modern human beings. Neanderthals were also large and muscular.

According to the multiple origins theory, today's human beings eventually developed from the Neanderthals and other groups of early *H. sapiens* who lived in different parts of Europe, Africa, and Asia. In time, these groups evolved higher, more rounded skulls. Their large browridges and protruding faces gradually disappeared, and they developed a chin. But they maintained certain differences in appearance that had developed during their long evolution in different regions. These local differences now distinguish different groups of modern peoples around the world.

The best evidence supporting the multiple origins

theory comes from a series of skulls found in Indonesia and Australia. In age, these skulls span a period that began about 1 million years ago and lasted until the appearance of physically modern people about 100,000 years ago. All the skulls show similar features characteristic of that part of the world. The fossils appear to represent a population that continuously evolved and, over time, resulted in modern Southeast Asian peoples.

A few anthropologists who accept the multiple origins theory believe that the earliest human beings, those who lived about 2 million years ago, did not form a separate species, such as *Homo erectus.* Instead, they believe that the earliest people belonged to the same species as modern people, *Homo sapiens.* According to these scientists, the key difference between the first people and their prehuman ancestors was the way they lived and obtained food, including their use of stone tools and their greater reliance on hunting. These anthropologists believe that all human beings, early and late, and including those with browridges, no chins, and small brains, should be called *Homo sapiens.*

The single origin theory, like the multiple origins theory, begins with the spread of *H. erectus* out of Africa—perhaps as early as 1,600,000 years ago—and into Asia and eventually Europe. According to the single origin theory, however, the scattered population groups did not maintain contact from their different continents.



Ofer Bar-Yosef, Harvard University

A Neanderthal grave from Kebara Cave in Israel contains a human skeleton that is about 60,000 years old. Such graves suggest that the Neanderthals were the first to bury their dead.

For this reason, they eventually became separate species in Africa, Asia, and Europe. The Neanderthals were one of these species, *Homo neanderthalensis.*

According to the single origin theory, the first *Homo sapiens* appeared in Africa between 200,000 and 100,000 years ago, having developed from earlier human beings in that region. Soon afterward, *H. sapiens* spread to other parts of Africa, as well as to Asia and Europe, replacing the earlier peoples who lived there. All these earlier peoples, such as the Neanderthals, became extinct.

According to the single origin theory, the development of different physical characteristics in today's so-called racial groups began with the spread of *H. sapiens* from Africa between 200,000 and 100,000 years ago. This development would have occurred much later than that portrayed in the multiple origins theory. According to that theory, modern human population differences originated with the first spread of early human beings out of Africa more than 1,500,000 years ago.

Some of the best fossil evidence that supports the single origin theory comes from cave sites in Israel. At two of these sites, called Qafzeh and Skhul, archaeologists excavated fossil skeletons of modern-looking human beings that date from about 100,000 years ago. These people had a chin, a high forehead, and a smaller, less-protruding face than earlier peoples had. They also lacked the large browridge of earlier people and had a higher and more rounded skull. At another site nearby, called Kebara, a Neanderthal skeleton that dated from about 60,000 years ago was found. This fossil evidence shows that Neanderthals lived in the Middle East after the modern type of human beings appeared. Supporters of the single origin theory point out that it is difficult to place the Neanderthals as ancestors of modern human beings if they lived after modern human beings first appeared.

Some scientists also support the single origin theory through use of genetic evidence from living people. Molecular biologists have gained a greater understanding of human evolution by studying the rate of change of human genetic material. By calculating this rate, some scientists have concluded that all living people must have evolved from a small group of human ancestors who lived in Africa about 200,000 years ago. But some molecular biologists doubt that enough is known about human heredity to draw such a conclusion.

Cultural development after *Homo erectus*

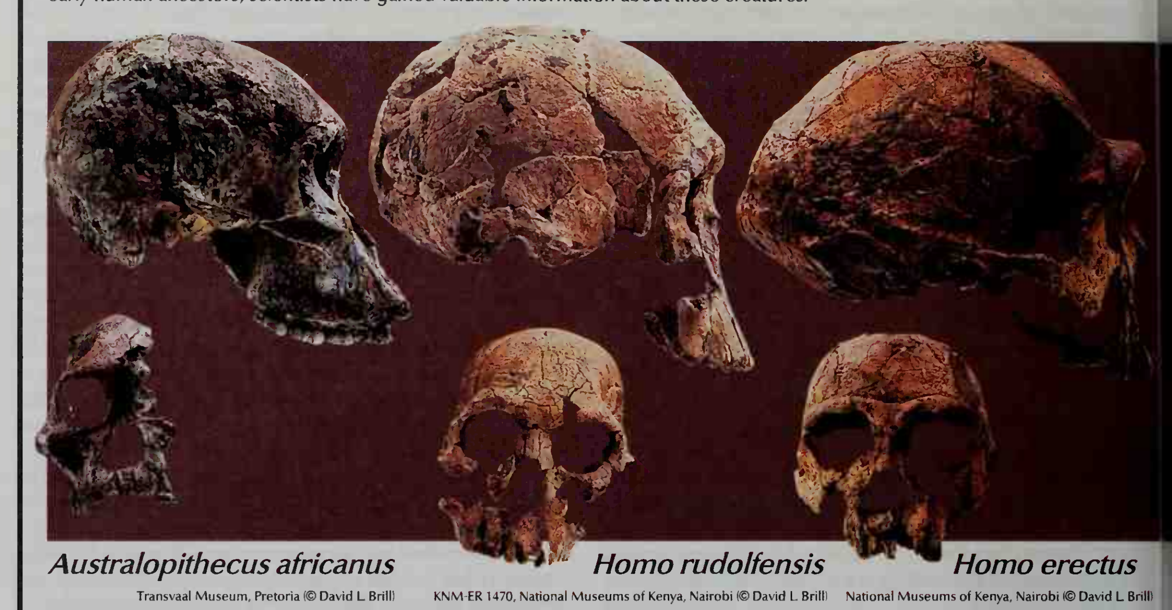
The culture of prehistoric people developed extensively after the time of *Homo erectus.* Some of this development occurred during the time of the Neanderthals. But human culture developed more rapidly after the appearance of physically modern people, especially after about 35,000 years ago.

Neanderthals were more skilled hunters and toolmakers than earlier people. The bones of many animals have been found at Neanderthal sites. Some of the bones indicate that these people hunted such large animals as horses, reindeer, and mammoths. But they had more success in capturing hares and other small animals. The Neanderthals made a variety of stone tools and used them to butcher animals, prepare vegetable foods, scrape hides, and carve wood. They also made sharp, pointed tools that may have been spearheads.

Neanderthals lived in Europe during the most recent

The development of prehistoric human beings

The skulls of prehistoric people changed dramatically over time. By studying the fossilized skulls of our prehuman and early human ancestors, scientists have gained valuable information about these creatures.



Australopithecus africanus
Transvaal Museum, Pretoria (© David L. Brill)

Homo rudolfensis
KNM-ER 1470, National Museums of Kenya, Nairobi (© David L. Brill)

Homo erectus
National Museums of Kenya, Nairobi (© David L. Brill)

© Jay H. Matternes

The evolution of human beings took place gradually over millions of years. The illustrations below are an artist's impression of how some of the major species of prehuman and early human ancestors may have looked.

Australopithecus afarensis (3.7 million years ago)

Australopithecus africanus (3 million years ago)

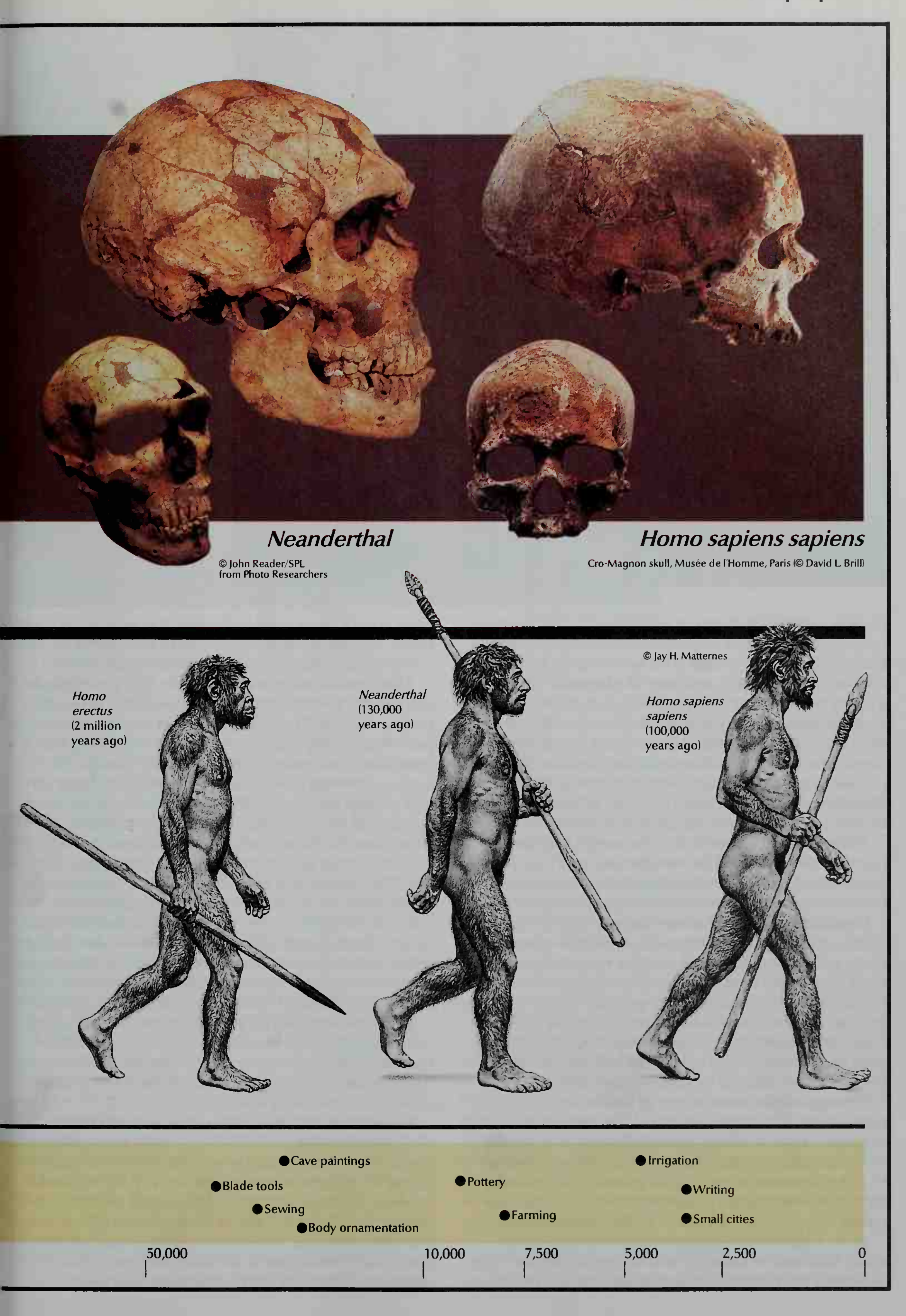
Australopithecus robustus (2.5 million years ago)

Homo habilis or *Homo rudolfensis* (2 million years ago)

Cultural developments

- Pebble tools
- Hand axes
- Ability to make fire
- Burial of the dead

Dates B.C. 3,000,000 | 2,000,000 | 1,000,000 | 750,000 | 500,000 | 250,000 | 100,000


Neanderthal
© John Reader/SPL from Photo Researchers
Homo sapiens sapiens
Cro-Magnon skull, Musée de l'Homme, Paris (© David L. Brill)
© Jay H. Matternes
Homo erectus (2 million years ago)
Neanderthal (130,000 years ago)
Homo sapiens sapiens (100,000 years ago)
Cave paintings
Blade tools
Sewing
Body ornamentation
Pottery
Farming
Irrigation
Writing
Small cities
50,000
10,000
7,500
5,000
2,500
0



WORLD BOOK illustration by Nathan Greene

© Lee Boltin



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Prehistoric tools were made chiefly of stone. Neanderthals made a variety of tools, including the hand axe, *top left,* and the scraper, *bottom left.* To form these tools, they used a hard object—such as a rock or bone—to chip pieces away from a carefully selected stone. Later prehistoric people used more complicated toolmaking techniques, such as the one shown on the far left. This process, employed by Upper Paleolithic people, required the cooperation of two individuals. The toolmakers used two hard objects as a hammer and chisel to split bladelike slivers from a large stone. In this way, they could create many useful tools from a single stone.

ice age, when vast sheets of ice covered many northern parts of the world. As a result, they developed qualities that enabled them to cope with harsh winter conditions. Archaeologists have found most evidence of Neanderthals in caves, where many of these people lived to escape the extreme cold. Archaeologists have also discovered sites where Neanderthals camped in the open. These sites provide evidence that the Neanderthals pitched large circular tents around a central hearth area. The tent covering probably consisted of hides, leaves, or bark and was supported by wooden posts.

The Neanderthals were the first people known to have buried their dead. In Neanderthal sites in Europe and the Middle East, archaeologists have uncovered the carefully buried skeletons of women, men, and children.

Physically modern human beings. The cultural activities of the first physically modern people resembled those of the Neanderthals and other early people who lived during that time. For example, the modern-looking human beings from the 100,000-year-old sites of Qafzeh and Skhul were found with the same kinds of stone tools that Neanderthals used nearby. Thus, the appearance of modern human beings did not represent a sudden change in lifestyle or culture from earlier people.

Throughout the early stages of human evolution, the rate of cultural change among prehistoric people was extremely slow. At times, stone tools and other products of human skill remained unchanged for many thousands of years. However, about 35,000 years ago, the rate of cultural change began to accelerate rapidly. This later period is generally referred to as the Upper Paleolithic.

In the Upper Paleolithic, prehistoric people made many advances in their way of life. The best-known type of human beings from this period are the Cro-Magnons. The Cro-Magnons lived in Europe, the Middle East, and North Africa from about 40,000 to 10,000 years ago. Scientists believe they resembled modern Europeans.

The improvement of tools was a major accomplishment of the Cro-Magnons and other Upper Paleolithic people. New tool types and methods of manufacture appeared at a rapid pace. Stone tools made during this time were more refined and complex in design. Toolmakers invented new devices to serve specialized carving, cutting, and drilling functions. Tools of bone, ivory, and animal horns also came into use. Archaeologists have found harpoons, fish spears, and needles made from bone that date from this period. These tools suggest the introduction of such activities as sewing close-fitting clothes and fishing with better equipment.

Upper Paleolithic fossil sites also indicate that these people had become skillful hunters. Some sites hold the remains of thousands of animals. In addition, the bones of mammoths, horses, and reindeer are common, suggesting these people hunted large animals successfully.

The appearance of art was one of the most spectacular developments of the Upper Paleolithic. The oldest known works of art date from this period. Furthermore, the practice of creating art seems to have spread rapidly in Europe, Africa, and Australia.

Some of the oldest artworks from the Upper Paleolithic were ornaments, such as beads made from polished shells. After about 30,000 years ago, prehistoric people began to produce a variety of artwork. They excelled at carving—creating beautiful sculptures of animals and people, usually from ivory or bone. They also made engravings of people, fish, birds, and other animals on bone, ivory, and stone. In addition, the Upper Paleolithic people sculpted clay, ivory, and stone figurines of



Ronald Sheridan Photo Library



J. Bergson, Art Diapo

Cave paintings were one of the earliest forms of art. Prehistoric people had begun producing them by about 30,000 years ago. Many cave paintings of deer, *left,* were found at Lascaux, a cave in southwestern France. The handprints of prehistoric people, *above,* decorate the walls of Gargas Cave in southern France. These prints show that some of the prehistoric artists had lost parts of their fingers.

women, which may have represented fertility.

A number of caves in Europe are covered with paintings, drawings, and engravings from the Upper Paleolithic. Most distinctive of these are the paintings, which appear on the cave walls and ceilings. Most of the paintings are of the animals early people probably hunted, including bison, mammoths, and horses. Some of the paintings show animals that have been speared.

Many of the paintings are of a high artistic quality. Paleolithic artists used three basic colors: black, red, and yellow. They got these pigments from natural sources, including charcoal, clay, and iron and other minerals.

The development of speech. No one knows when or how spoken language developed. However, many anthropologists think that human beings may have first begun to speak sometime during the Upper Paleolithic. These scientists believe that the many cultural developments that occurred at this time—especially the appearance of art—may be related to the development of speech. The beginnings of speech, the creation of artwork, and the making of complex tools all required advancements in human intelligence and cooperation.

The spread of settlement. Prehistoric people spread into new areas during the Upper Paleolithic period. Cultural and technological advances enabled them to migrate to such places as Australia, the Pacific Islands, and North and South America.

As early as 65,000 years ago, people used boats to reach Australia. About 20,000 years ago, people from Australia and Asia began to colonize the Pacific Islands. These people used sophisticated navigational systems involving knowledge of the stars, water currents, and wind direction. They also used simple navigational tools.

By 130,000 years ago, human beings had spread to the cold, harsh plains of western Siberia, but not until later did people move into the eastern part of the region. At that time, because so much water had been frozen as glacial ice, the level of the oceans and seas was lower than it is today. As a result, the Bering Strait was dry and formed a land bridge between northeast Asia and North America. Most scientists believe prehistoric people crossed this bridge and were living in North America by about 15,000 to 20,000 years ago. Eventually, early modern people populated all of North and South America.

The most recent ice age ended about 11,500 years ago. As the ice receded, the environment of many prehistoric people changed and greatly affected their way of life. In some areas, such as Europe, forests began to spread across the land. The people of these areas learned to hunt new species of animals and gather new varieties of plants from the forests. In other parts of the world, people began to experiment with methods of controlling their supply of food. This led to farming.

The rise of agriculture, according to most scientists, began in the Middle East about 10,000 years ago, or 8000 B.C. The first farmers lived in a region called the Fertile Crescent, which covers what is now Lebanon and parts of Iran, Iraq, Israel, Jordan, Syria, and Turkey. At first, these people probably did not depend entirely on the crops they raised. But as they improved their methods, farming became their most important source of food. The earliest plants grown in the Middle East were probably barley and wheat. Early farmers in the Middle East eventually raised cattle, goats, and sheep.

The first farmers originated in areas where there were enough wild plants and animals to provide food for

Where remains of prehistoric people have been found

The earliest fossils and other remains of prehistoric people have been found in Africa, Asia, and Europe. Most scientists believe that our closest prehuman ancestors originated in Africa, and prehistoric people later spread to other parts of the world.

★ Unclassified

● Australopithecus
○ Ardipithecus

■ Homo habilis
□ Homo rudolfensis
◆ Homo erectus

▲ Homo sapiens
△ Neanderthals

WORLD BOOK map



Important fossils of prehistoric people and their prehuman ancestors

Fossil	Location	Date found	Discovered or identified by	Importance
		Ardipithecus and Australopithecus		
Ardipithecus ramidus	Aramis, Ethiopia	1994	Tim White (U.S.), Gen Suwa (Japanese), Berhane Asfaw (Ethiopian)	Oldest known hominid, dating from about 4,400,000 years ago
Taung child	Taung, South Africa, near Vryburg	1924	Raymond A. Dart (South African)	First australopithecine discovered
Kromdraai hominid (formerly *Paranthropus robustus*)	Kromdraai, South Africa, in the Sterkfontein Valley	1938	Robert Broom (South African)	First *A. robustus* discovered
OH 5, nicknamed "Zinj" (formerly *Zinjanthropus boisei*)	Olduvai Gorge, Tanzania	1959	Mary D. Leakey (British)	First East African australopithecine found
"Lucy"	Hadar, Awash River Valley, Ethiopia	1974	Donald C. Johanson (U.S.)	One of the most complete australopithecine skeletons
Laetoli fossil footprints	Laetoli, Tanzania, near Lake Eyasi	1978	Mary D. Leakey (British)	Evidence that australopithecines walked erect
Anamensis fossils	Kanapoi, Kenya; Lake Turkana, Kenya	1994	Peter Nzube Mutiwa (Kenyan)	Oldest australopithecine
		Homo habilis and Homo rudolfensis		
Olduvai Gorge *Homo habilis*	Olduvai Gorge, Tanzania	1960	Jonathan Leakey (Kenyan)	First *H. habilis* found
KNM-ER 1470	Lake Turkana (formerly Lake Rudolf), Kenya	1972	Bernard Ngeneo (Kenyan)	Oldest known *H. rudolfensis* skull
		Homo erectus		
Java fossils (formerly *Pithecanthropus erectus*)	Trinil, Indonesia, on the Solo River, island of Java	1891	Eugène F. T. Dubois (Dutch)	First *H. erectus* found
Peking fossils	Zhoukoudian, near Beijing	1921-1937 1949-1966	Davidson Black (Canadian)	Largest collection of *H. erectus fossils* found
East Turkana *Homo erectus*	Lake Turkana, Kenya	1975	Richard E. F. Leakey (Kenyan)	Oldest African *H. erectus* found, about 1,800,000 years old
Nariokotome boy	Lake Turkana, Kenya	1984	Kamoya Kimeu (Kenyan)	Skeleton of a boy, the most complete *H. erectus* found
		Homo sapiens and Neanderthals		
Kabwe fossil (formerly Rhodesian man)	Kabwe (also known as Broken Hill), Zambia	1921	Arthur Smith Woodward (British)	Early African *H. sapiens*
Dali skull	Dali, Shanxi Province, China	1978	Wu Xinzhi (Chinese)	Early Asian *H. sapiens*
Neanderthal	Neander Valley, Germany, near Düsseldorf	1856	Johann K. Fuhlrott (German)	First fossil recognized as remains of prehistoric people
"Old Man" of La Chapelle-aux-Saints	La Chapelle-aux-Saints, France, near Brive	1908	Amédée Bouyssonie and Jean Bouyssonie (French)	Most complete Neanderthal skeleton
Skhul skeletons	Skhul Cave, Mount Carmel, Israel	1931-1932	Theodore D. McCown and Hallam L. Movius (U.S.)	Early modern humans (*H. sapiens sapiens*), dating from 100,000 years ago
Qafzeh skeletons	Qafzeh Cave, near the Sea of Galilee, Israel	1933-1975	René Neuville and Bernard Vandermeersch (French)	Early *H. sapiens sapiens*, dating from 100,000 years ago
Cro-Magnons	Les Eyzies, France, near Brive	1868	Louis Lartet (French)	First Cro-Magnon skeletons discovered

large populations. As a result, people often settled in permanent villages for years at a time. At the end of the Ice Age, the climate became warmer and affected the food supply. New plants, such as grains, replaced older plants. Scientists believe that Upper Paleolithic people could live in permanent settlements because they discovered how to control these new plants and increase the amount of food in their area. They learned that they could plant seeds from the plants they ate. They also learned that they could domesticate animals, perhaps by capturing young ones from the wild and raising them. In time, people began to depend on these planted crops and domestic animals for a steady supply of food.

People were herding cattle and growing grain in northern Africa by 6000 B.C. By about 5000 to 4000 B.C., agriculture had developed independently in Asia. In the Yangtze Valley of China, and perhaps in what is now Thailand, farmers grew rice and millet. By the same time, people had begun to farm in the Indus River Valley of what is now Pakistan.

Between about 4500 and 4000 B.C., farming peoples spread from southeastern Europe into the dense forests of central and western Europe. These people brought wheat and cattle with them. Foraging people in Scandinavia learned how to farm from these newcomers.

Agriculture began to develop in southern Africa by about 3000 B.C. By 1500 B.C., people had begun to cultivate corn and beans in what is now Mexico. By 1000 B.C., peoples in what became the eastern United States were raising gourds and sunflowers. Farming began later in other parts of North America.

Changes in lifestyle. Prehistoric farmers, called *Neolithic* people, had a way of life that differed from that of Upper Paleolithic people. In some ways, farming made life easier. It provided a steady supply of food and enabled people to live in one place for a long time. But farmers had to work more than hunters and gatherers.

Prehistoric farmers set up villages near their fields and lived there as long as their crops grew well. Most fields produced good crops for a few years. The land then became unproductive because the crops used up nutrients in the soil. The farmers did not know about fertilizers. They shifted their crops to new fields until none of the land near their village was fertile. Then they moved to a new area and built another village. In this way, farmers settled many new areas.

Prehistoric farmers built larger, longer-lasting settlements than the camps that Paleolithic people had built. In the Middle East, for example, early farmers constructed their houses of solid, sun-dried mud, sometimes on stone foundations. Dried mud was much more resistant to weather than the materials earlier people used, such as skins and bark. The early farmers also learned to build fences to confine and protect their livestock.

The end of prehistoric times. Neolithic farmers made inventions and discoveries at an even faster rate than did the people of the Upper Paleolithic. Early farmers developed a number of useful tools. These implements included sickles to cut grain, millstones to grind flour, and polished stone axeheads.

Perhaps as early as 9000 B.C. in Japan, and somewhat later in the Middle East, people discovered how to make pottery. Before then, they used animal skins or bark containers to hold water. To boil water, early cooks had to drop hot stones into the water because they could not hang animal skins or bark over a fire. Pottery containers enabled people to hold and boil water easily. Farmers also used pottery to store grain and other food.

No one knows when people made the first objects out of metal. But metals became important only after metalworkers learned to make bronze, a substance hard and durable enough to make lasting tools. People of the Middle East made bronze as early as 3500 B.C. The Bronze Age began when bronze replaced stone as the chief toolmaking material. In some areas, such as the Near East, the Bronze Age began about 3000 B.C.

The development of farming was an important step toward the rise of civilization. As farming methods improved and food became more plentiful, many people were freed from the jobs of food production. These people developed new skills and trades. In addition, the abundant food supply enabled more people to live in each community. In time, some farming villages became cities. The first cities appeared by about 3500 B.C. These cities were the birthplaces of modern civilization.

Archaeologists believe writing was invented about 3500 B.C. in cities in the Tigris-Euphrates Valley in what is now Iraq. People then learned to record their history, and prehistoric times came to an end.

Studying prehistoric people

Since the mid-1800's, scientists have learned much about prehistoric people and their ways of life. They have used various methods to obtain this knowledge.

Studying fossils of prehistoric people has provided anthropologists with much of their most valuable information. Human fossils give direct evidence of what prehistoric people looked like, what they ate, how long they lived, and how their lives differed from ours.

Unfortunately, fossil bones and teeth are scarce because certain unusual conditions must be present for a fossil to form. An animal or person must be buried soon after death, and minerals from the soil must gradually replace the bony material to create a fossil. Also, the bones and teeth that do become fossils have often been broken, damaged, or distorted by the weight of the deposits in which they were buried. Soft tissues—such as skin, hair, and internal organs of prehistoric people—decay without leaving any fossil remains. As a result, scientists cannot determine certain characteristics of early human beings, such as the shape of their nose, the color of their skin, or the texture of their hair.

After a fossil is discovered, scientists first determine whether it came from an adult or a child and whether the individual was a male or a female. Anthropologists then compare the fossil with similar structures from other extinct hominids, living people, and apes. These examinations enable scientists to better understand the specimen's place in human evolution. Later, anthropologists study the fossil to determine a relationship between the individual's physical structure and its way of life. For example, looking at the way the teeth have been worn down often provides clues about the foods the individual ate. The chemicals in fossil bones can also give clues about the diet of extinct hominids.

Examining prehistoric sites is another method anthropologists use to gain information about prehistoric people and their way of life. These sites may be places

where prehistoric people camped, made tools, butchered animals, or buried their dead.

The excavation of prehistoric sites is a complicated process. Archaeologists carefully scrape away soil, sand, or rock to reveal tools, bones, pottery, and other evidence of early human life. They make detailed notes and maps, often using computers to record the exact position of all important items. They later use these records to precisely reconstruct the layout of the site. By studying the objects they find and the layout of the site, scientists learn how prehistoric people used the site and how these activities fit into their way of life.

Today, archaeologists avoid excavating the entire site they are working on. They try to leave enough of the ancient deposit so that future scientists, with more advanced techniques, can return to the site and learn still more about the people who lived there.

Scientists have found much evidence of prehistoric people's lives at sites up to 100,000 years old. These sites have produced ancient tools, pottery, artwork, bits of clothing, traces of dwellings, and evidence of food, such as animal bones and plant material. Sometimes, burial sites are found. These clues enable anthropologists to form a fairly detailed picture of early people's lives. Unfortunately, scientists have found little of this type of evidence at sites older than 100,000 years. As a result, we know much less about hominids who lived before then.

Placing prehistoric people in time is an important element of learning about human ancestors. To understand the significance of a newly discovered hominid fossil, scientists must determine how that hominid relates to others that have already been studied. This relationship can be determined by *dating* the newly found fossil—that is, by determining when it was alive.

Scientists have traditionally dated fossils by studying the deposit in which the fossil was found. Based on knowledge of geological history, scientists can determine the age of the deposit. They then interpret this information to provide an approximate age for the fossil.

Other dating methods are much more accurate. These methods are based on the fact that certain *radioactive isotopes* (unstable forms of chemical elements) decay at a known rate and form different isotopes. By measuring the amount of each isotope in a fossil, scientists can determine how long the decay has been going on and therefore how old the fossil is. The most commonly used dating methods of this type are *radiocarbon dating* and *potassium-argon dating.* Radiocarbon dating is sometimes called *C-14 dating.* Potassium-argon dating is also known as *K/AR dating.* Other methods include *electron spin resonance* and *thermoluminescence,* which involve dating rocks found at archaeological sites.

Analysis of the genetic materials of living people is another recently developed method of studying prehistoric people. This method largely involves the study of the genetic material DNA (deoxyribonucleic acid).

Molecular biologists in this field examine DNA from living people and compare it with DNA from other people and from apes and other living primates. Some scientists have extracted DNA from the bones of prehistoric people, though the process is extremely difficult.

Using genetic samples, scientists study the rate of change that DNA appears to go through during evolution. Scientists often use computers to help analyze data obtained through this research. From these studies, they have gained valuable knowledge about the relationship between living people and their ancestors. In many cases, however, anthropologists have disagreed on how to best interpret the results of these studies. Alan E. Mann



Alan E. Mann, University of Pennsylvania

Anthropologists dig for objects left behind by prehistoric people. The scientists above are digging at St.-Césaire, France, a site occupied by Neanderthals about 35,000 years ago.

Related articles in *World Book* include:

Anthropology
Archaeology
Australopithecus
Bronze Age
Cave dwellers
Cro-Magnons
Evolution
Fossil
Heidelberg jaw
Homo erectus
Homo habilis
Java fossils
Johanson, Donald C.
Lake dwelling
Leakey, Louis S. B.
Leakey, Mary D.
Leakey, Meave G.
Leakey, Richard E. F.
Megalithic monuments
Neanderthals
Peking fossils
Piltdown hoax
Pleistocene Epoch
Races, Human
Stone Age
Swanscombe fossil

Outline

I. **Prehuman ancestors**
   A. Where and when they lived
   B. What they looked like
   C. Types of australopithecines
II. **The first human beings**
   A. Three species
   B. How they lived
III. **The development of *Homo sapiens***
   A. The multiple origins theory
   B. The single origin theory
IV. **Cultural development after *Homo erectus***
   A. Neanderthals
   B. Physically modern human beings
V. **Studying prehistoric people**
   A. Studying fossils
   B. Examining prehistoric sites
   C. Placing prehistoric people in time
   D. Analysis of genetic materials

Questions

When did the first human beings live?
What are *hominids*?
From what type of prehuman creature did the first human beings evolve?
Who were the first prehistoric people to master the use of fire?
When did scientists first find evidence of prehistoric people?

How do scientists use computers to study prehistoric sites?
According to many scientists, what were the first three human species?
How did early human beings make tools out of stone?
Who were the Neanderthals?
Why did some prehistoric people become farmers?

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Prejudice is an opinion formed without taking the time or care to judge fairly. Such an opinion may be favorable or unfavorable and is held without regard to the available evidence. In this article, *prejudice* refers to an unfavorable opinion held in this way about the members of a particular social group. Prejudiced individuals tend to twist, distort, misinterpret, or even ignore facts that conflict with their predetermined opinions. For example, a prejudiced person might believe that all individuals of a certain age, national origin, ethnic group, religion, sex, or region of the country are lazy, violent, stupid, emotionally unstable, or greedy.

Due to prejudice, people have been denied jobs, housing, education, and participation in government. In Nazi Germany, extreme prejudice led to the killing of millions of Jews and other members of minority groups in the 1930's and during World War II (1939-1945).

A number of elements may contribute to prejudice. These elements include (1) competition, (2) religious ideas, (3) fear of strangers, and (4) extreme nationalism. Prejudice may develop when one group fears that competition from another group will deprive them of prestige, privilege, political power, or economic opportunities. Religious ideas—especially a lack of tolerance for religions other than one's own—have contributed to prejudice against certain races and religious groups. Some people have suggested that prejudice arises from a natural fear of strangers. Extreme nationalism may cause prejudice by encouraging people to regard foreign characteristics as inferior.

Education, certain types of contact between groups, and institutional change may help reduce prejudice. Education helps correct false generalizations that form the basis of prejudice. Contact between groups is most likely to reduce prejudice when the groups work together for a common cause. Changes in institutions, laws, and customs to reduce discrimination might eliminate some prejudice. William Julius Wilson

Related articles in *World Book* include:

Anti-Semitism
Ethnic group
Ethnocentrism
Hate crime
Minority group
Races, Human (Race and discrimination)
Racism
Segregation

Premature birth, *PREE muh CHUR,* occurs when a woman gives birth to a baby before the end of the normal period of pregnancy. The normal period of pregnancy ranges from 37 to 41 weeks after a woman begins her last menstrual period prior to becoming pregnant. Births that take place before the end of 37 weeks of pregnancy are said to occur *preterm.*

Most premature infants that weigh more than 3 $\frac{1}{3}$ pounds (1.5 kilograms) at birth grow up as healthy as babies born after a normal pregnancy. Premature babies weighing less than 2 $\frac{1}{5}$ pounds (1 kilogram) at birth have the poorest chance of survival.

In many premature infants, certain organs—especially the lungs—have not developed sufficiently for the baby to survive without medical assistance. *Hyaline membrane disease,* also called *respiratory distress syndrome,* ranks among the most serious lung disorders that strike these babies. Some infants with this condition are attached to a respirator (see **Hyaline membrane disease**). Other common problems include the inability to digest normal-sized feedings and the body's lack of adequate control over its temperature. If the baby can suck and swallow, special formulas may be given by bottle. Some premature infants must be fed by means of a tube passed through the nose and into the stomach. Others may need to be fed entirely through a tube inserted into a blood vessel. Most premature infants are placed in an incubator to assure a constant body temperature.

Premature births occur least often among healthy women who receive periodic medical care. A woman can help assure normal birth by eating a well-balanced diet and by avoiding the use of tobacco, alcohol, and all drugs except those recommended by her doctor. In the United States, about 7 percent of white babies and 14 to 15 percent of nonwhite babies are born prematurely.

The causes of preterm births are poorly understood. Factors involved include conditions in the mother, the baby, and the *placenta.* The placenta is an organ that develops during pregnancy, joining the mother and the unborn baby. Many women have a medical condition associated with premature birth. Such conditions include abnormalities of the uterus, drug addiction, high blood pressure, and being pregnant with more than one baby. A woman who has had a premature baby or a miscarriage has about a 20 percent chance of again giving birth prematurely. Scientists have developed a number of drugs that can help stop preterm labor before it results in premature birth. Lois Kazmier Halstead

See also **Neonatology.**

Premenstrual syndrome (PMS) is a condition that affects many women 3 to 10 days before the beginning of their menstrual period. The syndrome has a variety of symptoms, including anxiety, depression, sudden mood changes, crying easily, feeling angry or irritable, headaches, swelling, breast soreness, constipation, food cravings, and fatigue. Women affected by PMS may have any number of these symptoms at the same time, and the symptoms may be mild or severe.

The cause of PMS is unknown. Most doctors believe the symptoms result from hormone changes that take place during the menstrual cycle. See **Menstruation.**

Doctors distinguish PMS from other conditions by the time at which it occurs. If the symptoms occur during the few days before the woman's menstrual period

begins and at no other time, the condition is PMS.

Some women can ease symptoms of PMS by exercising regularly and by changing their diet to meet the needs of the body. Many women with severe symptoms need medication for relief. Drugs that prevent the normal hormone changes of the menstrual cycle seem to be the most effective. Mona M. Shangold

Premier. See Prime minister.

Prendergast, *PREHN duhr GAST,* **Maurice Brazil,** *MAW rihs BRAZ uhl* (1859-1924), was an American painter and illustrator. Prendergast's paintings capture the life and movement of crowds in city parks and at the seaside. They show his familiarity with European Postimpressionist handling of form, color, and light.



Oil painting on canvas; the Metropolitan Museum of Art, George A. Hearn Fund, 1950. Photograph © the Metropolitan Museum of Art

A Prendergast painting called *Central Park* was completed about 1910. Its patchy color, thick brushstrokes, and outdoor subject matter are typical of the artist's Postimpressionist style.

Prendergast was born in St. John's, Newfoundland, and grew up in Boston. He was attracted by Robert Henri's philosophy of independent and spontaneous expression in art. In 1908, he exhibited with Henri's group of realistic painters called *The Eight* (later called the *Ashcan School* by critics). In 1913, Prendergast exhibited in the Armory Show of modern art in New York City.

Charles C. Eldredge

See **Ashcan School; Henri, Robert.**

Preposition, in grammar, is a word that introduces a word or phrase and connects that word with the word it modifies. In "The house beside the stream," *beside* is a preposition. It has an object, *stream.* The phrase as a whole acts as an adjective modifying *house.*

There are only about 60 English prepositions. The most common include *at, by, in, for, on, to,* and *with.* Prepositions must have objects, the words or phrases that they introduce. Thus, *down* is a preposition in the sentence "Mary fell *down* the well." In the sentence "Mary fell *down,*" *down* has no object and is an adverb.

Some prepositions express clear meanings, such as time *(before, during, following),* or location *(against, near).* Other prepositions function mainly to express grammatical meanings, as in "The barking *of* the dogs kept me awake." By definition, prepositions are single words, but there are multiword phrases of the form *preposition-noun-preposition.* These phrases function as a unit *(by means of, in addition to, in spite of).*

Prepositions also are used with nouns, adjectives, and verbs in an *idiomatic* sense—that is, the combination of words assumes a special meaning. For example, we may *agree with, agree to, agree on, agree about,* or *agree among.* We may have a preference *for* something, but choose one thing in preference *to* another. We may be doubtful *of* or *about.* A woman may be impatient *with* her secretary or impatient *for* the arrival of a friend. No rules explain the differences in usage.

It used to be said that one should never end a sentence with a preposition. However, this rule is now considered old-fashioned and never really described actual usage. Prepositions ordinarily precede their objects, but that order need not be followed. Most people recognize that "He knew what he came *for*" is a more natural expression than "He knew *for* what he came."

In many of the world's languages, such as Japanese, the equivalent of English prepositions come after their objects. Since these words come after rather than before their object, they are called *post*positions rather than *pre*positions. Susan M. Gass

Pre-Raphaelite Brotherhood, *pree RAF ee uh lyt,* was a group of seven young English artists and writers who wanted to reform England's art. They chose the name in 1848. They called themselves Pre-Raphaelites because they admired the simple, informal style of Italian painting before the work of Raphael in the early 1500's. In 1850, the group published a magazine, *The Germ,* to illustrate and spread their doctrines.

The leading Pre-Raphaelites were William Holman Hunt, Sir John Everett Millais, and Dante Gabriel Rossetti. They were resolved to paint according to nature, not according to rules. This led them to use striking color and minute, abundant detail. The paintings and poems of the group are often heavily symbolic. Many are set in the distant past, and a number of them have religious and literary themes. English critics ridiculed the Pre-Raphaelites at first. The group gained acceptance after receiving the support of English art critic John Ruskin. The Pre-Raphaelite Brotherhood broke up in 1854.

K. K. Collins



Oil on canvas; Manchester City Art Gallery, England

A Pre-Raphaelite painting called *The Hireling Shepherd* was painted in 1851 by William Holman Hunt. The painting shows the detailed realism and rich color typical of the group's style.

See also Burne-Jones, Sir Edward; Millais, Sir John E.; Rossetti, Dante G.

Presbyter John. See Prester John.

Presbyterian Church (U.S.A.), *PREHZ buh TIHR ee uhn,* is the largest Presbyterian denomination in the United States. It was formed in 1983 through a union of the United Presbyterian Church in the U.S.A. and the Presbyterian Church in the United States.

The Presbyterian Church (U.S.A.) has about 2,600,000 members. The members belong to congregations governed by a board called a *Session.* The congregations are organized into regional *presbyteries.* The presbyteries elect members to regional governing bodies called *synods.* A General Assembly meets annually to decide matters concerning the church's constitution.

Critically reviewed by the Presbyterian Church (U.S.A.)

Presbyterians, *PREHZ buh TIHR ee uhnz,* form a large group of Protestant denominations in English-speaking countries. Outside these countries, most churches of this tradition are called *Reformed*—for example, the Dutch Reformed Church. About 100 denominations belong to the World Alliance of Reformed Churches.

The term *presbyterian* refers to a distinctive pattern of church government. *Presbyter* is the New Testament term for *elder.* Presbyterian congregations are governed by boards, called *sessions* or *consistories,* composed of the minister and lay elders. The sessions send representatives to church councils, called *presbyteries* or *classes,* which oversee the congregations of the district. The presbyteries are represented in regional *synods* or *assemblies.* Representative government operates at all levels, with lay elders participating equally with ministers. All the ministers have equal rank.

Teaching and worship. The Presbyterian and Reformed tradition has always referred to the Bible as the final religious authority. The churches have produced a series of official statements expressing their understanding of Biblical truth. Of these basic documents of Reformed theology, the two best-loved and most influential are the *Heidelberg Catechism* (1563) and the *Westminster Shorter Catechism* (1647). The earlier catechism is widely used in Europe, and the later one is more popular in English-speaking countries. The American Presbyterian *Confession of 1967* is another official statement.

The most influential theologian in the developing years of the Reformed tradition was John Calvin. He was more a commentator on the Bible than a systematic thinker, and scholars debate whether Calvin's thought can be summed up under any single theme. One central point in Calvin's thinking is the conviction that God is the actual present ruler over all creation. This belief is basic to the Reformed tradition generally.

Predestination is another important theme. It is less central in Calvin but more important in the thought of some later Reformed theologians. Predestination is a doctrine which states that God determines the eternal destiny of humanity. The conception is illustrated by Jesus's saying "You have not chosen me, it is I who have chosen you" (John 15:16). Predestination is no longer a characteristic theme of Reformed teaching.

In worship, the Reformed churches have always stressed preaching, along with the Biblical sacraments of baptism and the Lord's Supper. The Reformed churches have produced many great preachers. Congregational worship was once characterized by the singing of psalms translated into the *vernacular* (local languages) and arranged in meter. Within the last 100 or 200 years, hymns have generally replaced psalms. The formal *liturgies* (church services) during the Reformation of the 1500's were largely replaced by *free prayer* beginning in the 1600's. The Reformed churches have partially returned to set forms of worship.

History. The Reformed tradition has always been the most international of the main Protestant bodies. Unlike Anglicanism and Lutheranism, Reformed churches often had to organize without government support, and sometimes under persecution. Many of their leaders, including Calvin and John Knox, were exiles or refugees from France, England, Scotland, the Netherlands, Germany, Italy, Poland, or Hungary.

Geneva, Switzerland, was a notable international refugee center. From Geneva, Reformed ideas and leaders spread throughout Europe. Reformed churches were organized in nearly all European countries, each with its statement of faith, liturgy, and form of government.

The term *presbyterian* was not generally used for Reformed churches until the English Civil War of the 1640's. During the war, Parliament summoned the Westminster Assembly, a council of clergymen, to advise the government on church affairs. The assembly devised a plan of presbyterian organization for the Churches of England, of Scotland, and of Ireland. It also drafted the Westminster Confession, the Larger and Shorter catechisms, and a worship manual. This program did not survive the restoration of the monarchy in 1660. But the theology of the assembly documents remained influential for Presbyterians, Congregationalists, and most Baptists throughout the English-speaking world.

The Presbyterian and Reformed churches played an important part in the great missionary movement of the 1800's. About half the member churches of the present World Alliance are "younger" churches formed in Asia, Africa, and Latin America. In several cases, the Presbyterian and Reformed churches have played an important role in forming united churches with other denominations. This has been the case in China, Japan, south India, and the Philippines.

In 1983, the northern United Presbyterian Church in the U.S.A. and the southern Presbyterian Church in the United States voted to reunite. They formed the Presbyterian Church (U.S.A.). The nation's second largest Presbyterian church is the Presbyterian Church in America, with over 200,000 members. It was formed in 1973 and has headquarters in Atlanta, Georgia.

Henry Warner Bowden

Related articles in World Book include:

Calvin, John	Tennent, Gilbert
Knox, John	Tennent, William
Presbyterian Church (U.S.A.)	United Church of Canada
Reformation	

Prescott, Samuel (1751-1777?), was an American physician and patriot who completed Paul Revere's ride warning the colonists that the British were coming. At the start of the Revolutionary War in America, the British planned to destroy American military supplies stored in and near Concord, Massachusetts. Revere and William Dawes, another patriot, left Boston on April 18, 1775, to

warn the colonists. Prescott joined Revere and Dawes as they left Lexington shortly after 1 a.m. The three men continued toward Lexington until the British captured them. Prescott escaped and reached Concord. His warning enabled the patriots to hide some of the military supplies before the main British forces arrived.

Prescott was born in Concord. He became an army surgeon during the Revolutionary War. He was on a ship authorized to seize British merchant vessels when the British captured him at sea. Prescott died in a British prison in Halifax, Nova Scotia. James Kirby Martin

See also **Dawes, William; Revere, Paul.**

Prescott, William (1726-1795), was an American colonel during the Revolutionary War in America (1775-1783). He built the fortifications on Breed's Hill and led the militia in the Battle of Bunker Hill. It was once believed that Prescott said to his troops, "Don't fire until you see the whites of their eyes." But historians now question whether he gave this order.

Prescott was born in Groton, Massachusetts. He also fought in King George's War (1744-1748) and in the French and Indian War (1754-1763). Paul David Nelson

See also **Bunker Hill, Battle of.**

President is a title used by many heads of state and leaders of national governments. The term is also used to refer to the head of a corporation, college, institution, social club, or other organization. This article deals with presidents as national leaders.

Nearly three-fourths of the independent countries in the world have presidents as their heads of state. This number includes countries that have military dictators who take the title president.

More than four-fifths of the world's presidents are powerful leaders called *executive presidents.* They make many of the decisions and direct the actions of the government. Such presidents have the power to appoint many high government officials and, in many countries, may veto laws passed by the legislature. The rest of the world's presidents have a largely ceremonial role. These *nonexecutive presidents* act as official representatives of the country and carry out ceremonial duties.

A presidential system of government usually consists of separate *legislative* (lawmaking), *executive* (administrative), and *judicial* (court) branches. A president heads the executive branch. The president is normally elected directly by the people or, in some cases, by the legislature, to a fixed term of office. In theory, the president's powers and duties are described in a country's constitution. In practice, these powers are usually determined by political rather than legal or constitutional issues.

Types of presidential government

There are three types of executive presidency: (1) *limited,* (2) *dual,* and (3) *unlimited.* The main difference between the three types is the extent of the president's authority in relation to other members or sections of the country's government.

Limited presidency exists when a president is freely elected by the people for a specified term of office. A limited presidency is usually found in democratic countries where there is a well-developed multiparty system. Most countries with executive presidents have a limited presidential system. For example, the United States has a limited presidential government.

In a limited presidency, governing powers are divided among the president and other political institutions, such as a parliament or court system. The presidency and other sections of the executive branch operate within the framework of a constitution or legal code. In the United States, for example, the president's power is limited by the power of Congress to pass laws and pay the expenses of government. The Supreme Court of the United States, in its role as guardian of the U.S. Constitution, is another check on the president's power.

The United States style of presidential government provides a model for such Latin American states as Argentina, Brazil, Mexico, and Venezuela, and also for the Philippines. In nearly half of the countries with a limited presidential form of government, the United States model has been altered by the fact that the president appoints a prime minister to head his or her *cabinet* (group of advisers). In such cases, the president retains overall authority but concentrates on defense, foreign affairs, and long-term policy planning. The prime minister handles day-to-day administration and domestic affairs.

Dual presidency. A dual presidential form of government combines elements of both a presidential and a parliamentary system. A president and a prime minister share executive power. The president is generally elected by the people, and the prime minister is chosen from the party or *coalition* (group) of parties that has the support of a majority of the members of the legislature. For example, France has a dual presidency.

In France's dual presidential system, the president is elected for a renewable term of seven years and has considerable formal powers. For example, the president is the head of state and commander-in-chief of the armed forces, has the right to dissolve the National Assembly (France's parliament) once a year, and appoints the prime minister. The president also may preside over Cabinet and Defense Council meetings and call for a national vote on key issues, usually concerning the constitution. The appointed prime minister, who must have majority support within the National Assembly, has control over France's domestic activities.

France provides a model for dual presidential systems in Bulgaria, Finland, Lebanon, Poland, Portugal, and Turkey. When parliamentary and presidential elections take place at the same time, the president and prime minister usually belong to the same party. But if presidential and parliamentary elections occur at different times, the two leaders may belong to different parties and hold conflicting political views.

Unlimited presidency. Unlimited presidential government exists when a country has a chief executive whose authority is not subject to the checks and balances provided by a parliament or judicial system. Unlimited presidential government is usually found in *authoritarian countries,* one-party states run by a strong leader. Legislatures, where they exist, have little power and simply endorse the president's decisions. Several unlimited presidents have reached their positions by using the military to take control of the country by force. The majority of countries with unlimited presidents are in Africa and the Middle East. Thomas E. Cronin

See also **Government** (Presidential government); **President of the United States.**

Countries with presidents

*Country	Type	How chosen
Albania	Limited	Legislative vote
Algeria	Limited	Popular vote
Angola	Unlimited	Popular vote
Argentina	Limited	Popular vote
Armenia	Limited	Popular vote
Austria	Nonexecutive	Popular vote
Azerbaijan	Limited	Popular vote
Bangladesh	Nonexecutive	Legislative vote
Belarus	Limited	Popular vote
Benin	Limited	Popular vote
Bolivia	Limited	Popular vote
Bosnia-Herzegovina	Three-member rotating presidency; nonexecutive	Popular vote
Botswana	Limited	Legislative vote
Brazil	Limited	Popular vote
Bulgaria	Dual	Popular vote
Burkina Faso	Limited	Popular vote
Burundi	Limited	Coup
Cameroon	Limited	Popular vote
Cape Verde	Nonexecutive	Popular vote
Central African Republic	Limited	Popular vote
Chad	Limited	Popular vote
Chile	Limited	Popular vote
China	Nonexecutive	Legislative vote
Colombia	Limited	Popular vote
Comoros	Limited	Popular vote
Congo (Brazzaville)	Limited	Popular vote
Congo (Kinshasa)	Limited	Coup
Costa Rica	Limited	Popular vote
Côte d'Ivoire	Limited	Popular vote
Croatia	Limited	Popular vote
Cuba	Unlimited	Legislative vote
Cyprus[†]	Limited	Popular vote
Czech Republic	Nonexecutive	Legislative vote
Djibouti	Limited	Popular vote
Dominica	Dual	Legislative vote
Dominican Republic	Limited	Popular vote
Ecuador	Limited	Popular vote
Egypt	Limited	Legislative vote followed by popular referendum
El Salvador	Limited	Popular vote
Equatorial Guinea	Limited	Popular vote
Eritrea	Unlimited	Legislative vote
Estonia	Limited	Legislative vote
Ethiopia	Nonexecutive	Legislative vote
Fiji	Nonexecutive	Vote of Great Council of Chiefs
Finland	Dual	Popular vote
France	Dual	Popular vote
Gabon	Limited	Popular vote
Gambia	Limited	Popular vote
Georgia	Limited	Popular vote
Germany	Nonexecutive	Federal, state legislative vote
Ghana	Limited	Popular vote
Greece	Nonexecutive	Legislative vote
Guatemala	Limited	Popular vote
Guinea	Limited	Popular vote
Guinea-Bissau	Limited	Popular vote
Guyana	Limited	Vote of majority party members of the legislature
Haiti	Limited	Popular vote
Honduras	Limited	Popular vote
Hungary	Limited	Legislative vote
Iceland	Nonexecutive	Popular vote
India	Nonexecutive	Federal, state legislative vote
Indonesia	Limited	Vote of People's Consultative Assembly
Iran	Dual	Popular vote
Iraq	Unlimited	Vote of top officials of the ruling political party
Ireland	Nonexecutive	Popular vote
Israel	Nonexecutive	Legislative vote
Italy	Dual	Legislative vote
Kazakhstan	Limited	Popular vote
Kenya	Limited	Popular vote
Kiribati	Limited	Popular vote
Korea, South	Limited	Popular vote
Kyrgyzstan	Limited	Popular vote
Laos	Limited	Legislative vote
Latvia	Nonexecutive	Legislative vote
Lebanon	Dual	Legislative vote
Liberia	Limited	Popular vote
Lithuania	Limited	Popular vote
Macedonia	Limited	Popular vote
Madagascar	Dual	Popular vote
Malawi	Limited	Popular vote
Maldives	Limited	Legislative vote followed by popular referendum
Mali	Limited	Popular vote
Malta	Nonexecutive	Legislative vote
Marshall Islands	Limited	Legislative vote
Mauritania	Dual	Popular vote
Mauritius	Nonexecutive	Legislative vote
Mexico	Limited	Popular vote
Micronesia	Limited	Legislative vote
Moldova	Dual	Popular vote
Mongolia	Dual	Popular vote
Mozambique	Limited	Popular vote
Namibia	Limited	Popular vote
Nauru	Limited	Legislative vote
Nicaragua	Limited	Popular vote
Niger	Limited	Popular vote
Nigeria	Limited	Popular vote
Pakistan	Limited	Coup, followed by popular referendum
Palau	Limited	Popular vote
Panama	Limited	Popular vote
Paraguay	Limited	Popular vote
Peru	Limited	Popular vote
Philippines	Limited	Popular vote
Poland	Dual	Popular vote
Portugal	Dual	Popular vote
Romania	Limited	Popular vote
Russia	Limited	Popular vote
Rwanda	Limited	Coup
São Tomé and Príncipe	Limited	Popular vote
Senegal	Limited	Popular vote
Seychelles	Limited	Popular vote
Sierra Leone	Limited	Popular vote
Singapore	Dual	Popular vote
Slovakia	Limited	Popular vote
Slovenia	Nonexecutive	Popular vote
South Africa	Limited	Legislative vote
Sri Lanka	Limited	Popular vote
Sudan	Limited	Popular vote
Suriname	Limited	Legislative vote
Switzerland	Nonexecutive	Legislative vote
Syria	Limited	Popular vote
Taiwan	Limited	Popular vote
Tajikistan	Limited	Popular vote
Tanzania	Limited	Popular vote
Togo	Limited	Popular vote
Trinidad and Tobago	Nonexecutive	Legislative vote
Tunisia	Limited	Popular vote
Turkey	Dual	Legislative vote
Turkmenistan	Limited	Popular vote
Uganda	Limited	Popular vote
Ukraine	Limited	Popular vote
United Arab Emirates	Limited	Supreme Council vote
United States	Limited	Popular vote
Uruguay	Limited	Popular vote
Uzbekistan	Limited	Popular vote
Vanuatu	Nonexecutive	Legislative vote, vote of presidents of Regional Councils
Venezuela	Limited	Popular vote
Vietnam	Limited	Legislative vote
Yemen	Limited	Popular vote
Yugoslavia	Limited	Legislative vote
Zambia	Limited	Popular vote
Zimbabwe	Limited	Popular vote

Source: *The World Factbook 2001*, Central Intelligence Agency.
*Each country has an article in *World Book*.

†Northeastern Cyprus does not recognize the president of the Republic of Cyprus. Since 1974, northeastern Cyprus has considered itself a separate independent state, but no other country apart from Turkey recognizes it as independent.

President of the United States



The White House

The seal of the president of the United States includes an eagle holding arrows and an olive branch. The branch symbolizes the desire for peace, and the arrows represent the ability to wage war. The 50 stars stand for the 50 U.S. states.

President of the United States is often considered the most powerful elected official in the world. The president leads a nation of great wealth and military strength. Presidents have often provided decisive leadership in times of crisis, and they have shaped many important events in history.

The Constitution of the United States gives the president enormous power. However, it also limits that power. The authors of the Constitution wanted a strong leader as president, but they did not want an all-powerful king. As a result, they divided the powers of the United States government among three branches—executive, legislative, and judicial. The president, who is often called the *chief executive,* heads the executive branch. Congress represents the legislative branch. The Supreme Court of the United States and other federal courts make up the judicial branch. Congress and the Supreme Court may prevent or end any presidential action that exceeds the limits of the president's powers and trespasses on their authority.

The president has many roles and performs many duties. As chief executive, the president makes sure that federal laws are enforced. As commander in chief of the nation's armed forces, the president is responsible for national defense. As foreign policy director, the president determines United States relations with other nations. As legislative leader, the president recommends laws and works to win their passage. As head of a political party, the president helps mold the party's positions on national and foreign issues. As popular leader, the president tries to inspire the people of the United States to work together to meet the nation's goals. Finally, as chief of state, the president performs a variety of ceremonial duties.

A number of presidents became great leaders. The most admired ones include George Washington, Thomas Jefferson, Andrew Jackson, Abraham Lincoln, Theodore Roosevelt, Woodrow Wilson, Franklin D. Roosevelt, and John F. Kennedy. These leaders served as president when the United States faced extraordinary challenges. They also met those challenges with courage, determination, energy, imagination, and political know-how. Some of the most admired presidents at times ignored the U.S. Constitution or showed little regard for Congress. Nevertheless, their actions won public support. Therefore, like other great presidents, they broadened respect for the presidency and strengthened the office.

The presidency

Legal qualifications. The Constitution establishes only three qualifications for a president. A president must (1) be at least 35 years old, (2) have lived in the United States at least 14 years, and (3) be a natural-born citizen.

Courts have never decided whether a person born abroad to American parents could serve as president of the United States. However, many scholars believe that such a person would be considered a natural-born citizen.

Term of office. The president is elected to a four-year term. The 22nd Amendment to the Constitution

Facts in brief about the president

Qualifications: The United States Constitution provides that a candidate for the presidency must be a "natural-born" United States citizen. The candidate must also be at least 35 years old and must have lived in the United States for at least 14 years. No law or court decision has yet defined the exact meaning of *natural-born.* Authorities assume the term applies to citizens born in the United States and its territories. But they are not sure if it also includes children born to United States citizens in other countries.

How nominated: By a national political party convention.

How elected: By a majority vote of the Electoral College, held in December following the general election on the first Tuesday after the first Monday in November of every fourth year.

Inauguration: Held at noon on January 20 after election. If January 20 is a Sunday, the ceremony may be held privately that day and again in public on January 21.

Term: The president is elected to a four-year term. A president may not be elected more than twice.

Income: The president receives a yearly salary of $400,000. In addition, the president receives a $50,000 annual allowance for expenses, and additional allowances for travel, staff support, and White House maintenance.

Succession: If a president dies, resigns, is disabled, or is removed from office, the vice president assumes the office.

Portrait gallery of the presidents


1. George Washington


2. John Adams


3. Thomas Jefferson


4. James Madison


5. James Monroe

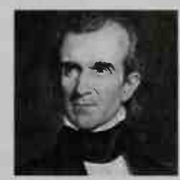

6. John Quincy Adams


7. Andrew Jackson


8. Martin Van Buren


9. William H. Harrison


10. John Tyler


11. James K. Polk

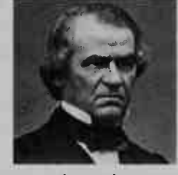

12. Zachary Taylor


13. Millard Fillmore


14. Franklin Pierce


15. James Buchanan


16. Abraham Lincoln


17. Andrew Johnson

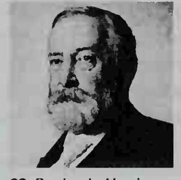

18. Ulysses S. Grant


19. Rutherford B. Hayes


20. James A. Garfield


21. Chester A. Arthur


22., 24. Grover Cleveland


23. Benjamin Harrison


25. William McKinley


26. Theodore Roosevelt


27. William H. Taft


28. Woodrow Wilson


29. Warren G. Harding


30. Calvin Coolidge


31. Herbert C. Hoover


32. Franklin D. Roosevelt


33. Harry S. Truman


34. Dwight D. Eisenhower


35. John F. Kennedy


36. Lyndon B. Johnson


37. Richard M. Nixon


38. Gerald R. Ford


39. Jimmy Carter


40. Ronald W. Reagan


41. George H. W. Bush


42. Bill Clinton


43. George W. Bush

The Presidents of the United States

President	Born	Birthplace	Political party	Age at inauguration	Served	Died	Age at death
1. **George Washington**	Feb. 22, 1732	Westmoreland County, Va.	None	57	1789–1797	Dec. 14, 1799	67
2. **John Adams**	Oct. 30, 1735	Braintree, Mass.	Federalist	61	1797–1801	July 4, 1826	90
3. **Thomas Jefferson**	Apr. 13, 1743	Albemarle County, Va.	Dem.-Rep.*	57	1801–1809	July 4, 1826	83
4. **James Madison**	Mar. 16, 1751	Port Conway, Va.	Dem.-Rep.*	57	1809–1817	June 28, 1836	85
5. **James Monroe**	Apr. 28, 1758	Westmoreland County, Va.	Dem.-Rep.*	58	1817–1825	July 4, 1831	73
6. **John Quincy Adams**	July 11, 1767	Braintree, Mass.	Dem.-Rep.*	57	1825–1829	Feb. 23, 1848	80
7. **Andrew Jackson**	Mar. 15, 1767	Waxhaw settlement, S.C. (?)	Democratic	61	1829–1837	June 8, 1845	78
8. **Martin Van Buren**	Dec. 5, 1782	Kinderhook, N.Y.	Democratic	54	1837–1841	July 24, 1862	79
9. **William H. Harrison**	Feb. 9, 1773	Berkeley, Va.	Whig	68	1841	Apr. 4, 1841	68
10. **John Tyler**	Mar. 29, 1790	Greenway, Va.	Whig	51	1841–1845	Jan. 18, 1862	71
11. **James K. Polk**	Nov. 2, 1795	near Pineville, N.C.	Democratic	49	1845–1849	June 15, 1849	53
12. **Zachary Taylor**	Nov. 24, 1784	Orange County, Va.	Whig	64	1849–1850	July 9, 1850	65
13. **Millard Fillmore**	Jan. 7, 1800	Locke, N.Y.	Whig	50	1850–1853	Mar. 8, 1874	74
14. **Franklin Pierce**	Nov. 23, 1804	Hillsboro, N.H.	Democratic	48	1853–1857	Oct. 8, 1869	64
15. **James Buchanan**	Apr. 23, 1791	near Mercersburg, Pa.	Democratic	65	1857–1861	June 1, 1868	77
16. **Abraham Lincoln**	Feb. 12, 1809	near Hodgenville, Ky.	Republican, Union†	52	1861–1865	Apr. 15, 1865	56
17. **Andrew Johnson**	Dec. 29, 1808	Raleigh, N.C.	Union‡	56	1865–1869	July 31, 1875	66
18. **Ulysses S. Grant**	Apr. 27, 1822	Point Pleasant, Ohio	Republican	46	1869–1877	July 23, 1885	63
19. **Rutherford B. Hayes**	Oct. 4, 1822	Delaware, Ohio	Republican	54	1877–1881	Jan. 17, 1893	70
20. **James A. Garfield**	Nov. 19, 1831	Orange, Ohio	Republican	49	1881	Sept. 19, 1881	49
21. **Chester A. Arthur**	Oct. 5, 1829	Fairfield, Vt.	Republican	51	1881–1885	Nov. 18, 1886	57
22. **Grover Cleveland**	Mar. 18, 1837	Caldwell, N.J.	Democratic	47	1885–1889	June 24, 1908	71
23. **Benjamin Harrison**	Aug. 20, 1833	North Bend, Ohio	Republican	55	1889–1893	Mar. 13, 1901	67
24. **Grover Cleveland**	Mar. 18, 1837	Caldwell, N.J.	Democratic	55	1893–1897	June 24, 1908	71
25. **William McKinley**	Jan. 29, 1843	Niles, Ohio	Republican	54	1897–1901	Sept. 14, 1901	58
26. **Theodore Roosevelt**	Oct. 27, 1858	New York, N.Y.	Republican	42	1901–1909	Jan. 6, 1919	60
27. **William H. Taft**	Sept. 15, 1857	Cincinnati, Ohio	Republican	51	1909–1913	Mar. 8, 1930	72
28. **Woodrow Wilson**	Dec. 29, 1856	Staunton, Va.	Democratic	56	1913–1921	Feb. 3, 1924	67
29. **Warren G. Harding**	Nov. 2, 1865	near Blooming Grove, Ohio	Republican	55	1921–1923	Aug. 2, 1923	57
30. **Calvin Coolidge**	July 4, 1872	Plymouth Notch, Vt.	Republican	51	1923–1929	Jan. 5, 1933	60
31. **Herbert C. Hoover**	Aug. 10, 1874	West Branch, Iowa	Republican	54	1929–1933	Oct. 20, 1964	90
32. **Franklin D. Roosevelt**	Jan. 30, 1882	Hyde Park, N.Y.	Democratic	51	1933–1945	Apr. 12, 1945	63
33. **Harry S. Truman**	May 8, 1884	Lamar, Mo.	Democratic	60	1945–1953	Dec. 26, 1972	88
34. **Dwight D. Eisenhower**	Oct. 14, 1890	Denison, Tex.	Republican	62	1953–1961	Mar. 28, 1969	78
35. **John F. Kennedy**	May 29, 1917	Brookline, Mass.	Democratic	43	1961–1963	Nov. 22, 1963	46
36. **Lyndon B. Johnson**	Aug. 27, 1908	near Stonewall, Tex.	Democratic	55	1963–1969	Jan. 22, 1973	64
37. **Richard M. Nixon**	Jan. 9, 1913	Yorba Linda, Calif.	Republican	56	1969–1974	Apr. 22, 1994	81
38. **Gerald R. Ford#**	July 14, 1913	Omaha, Nebr.	Republican	61	1974–1977		
39. **Jimmy Carter**	Oct. 1, 1924	Plains, Ga.	Democratic	52	1977–1981		
40. **Ronald W. Reagan**	Feb. 6, 1911	Tampico, Ill.	Republican	69	1981–1989		
41. **George H. W. Bush**	June 12, 1924	Milton, Mass.	Republican	64	1989–1993		
42. **Bill Clinton**	Aug. 19, 1946	Hope, Ark.	Democratic	46	1993–2001		
43. **George W. Bush**	July 6, 1946	New Haven, Conn.	Republican	54	2001–		

*Democratic-Republican.
†The Union Party consisted of Republicans and War Democrats.
#Inaugurated Aug. 9, 1974, to replace Nixon, who resigned that same day.

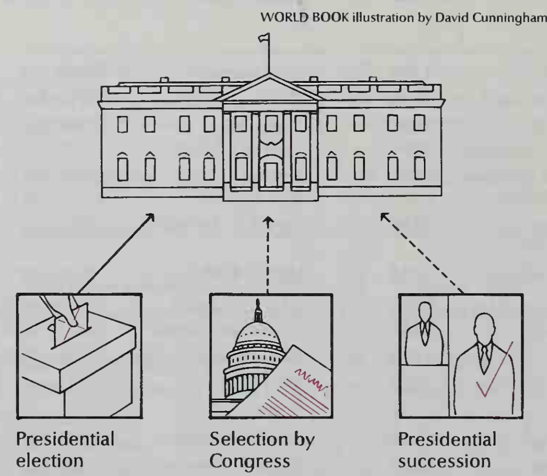
‡The Union Party consisted of Republicans and War Democrats; Johnson was a War Democrat.
Each President has a separate biography and picture in *World Book*.

	College or university	Religion	Occupation or profession	Runner-up		Vice President	
1.		Episcopalian	Planter	John Adams	(1789, 1792)	John Adams	(1789–1797)
2.	Harvard	Unitarian	Lawyer	Thomas Jefferson	(1796)	Thomas Jefferson	(1797–1801)
3.	William and Mary	Unitarian*	Planter, lawyer	Aaron Burr Charles C. Pinckney	(1800) (1804)	Aaron Burr George Clinton	(1801–1805) (1805–1809)
4.	Princeton	Episcopalian	Lawyer	Charles C. Pinckney De Witt Clinton	(1808) (1812)	George Clinton Elbridge Gerry	(1809–1812) (1813–1814)
5.	William and Mary	Episcopalian	Lawyer	Rufus King No opposition	(1816)	Daniel D. Tompkins	(1817–1825)
6.	Harvard	Unitarian	Lawyer	Andrew Jackson	(1824)	John C. Calhoun	(1825–1829)
7.		Presbyterian	Lawyer	John Quincy Adams Henry Clay	(1828) (1832)	John C. Calhoun Martin Van Buren	(1829–1832) (1833–1837)
8.		Dutch Reformed	Lawyer	William H. Harrison	(1836)	Richard M. Johnson	(1837–1841)
9.	Hampden-Sydney	Episcopalian	Soldier	Martin Van Buren	(1840)	John Tyler	(1841)
10.	William and Mary	Episcopalian	Lawyer			None	
11.	U. of N. Carolina	Methodist	Lawyer	Henry Clay	(1844)	George M. Dallas	(1845–1849)
12.		Episcopalian	Soldier	Lewis Cass	(1848)	Millard Fillmore	(1849–1850)
13.		Unitarian	Lawyer			None	
14.	Bowdoin	Episcopalian	Lawyer	Winfield Scott	(1852)	William R. King	(1853)
15.	Dickinson	Presbyterian	Lawyer	John C. Frémont	(1856)	John C. Breckinridge	(1857–1861)
16.		Presbyterian*	Lawyer	Stephen A. Douglas Geo. B. McClellan	(1860) (1864)	Hannibal Hamlin Andrew Johnson	(1861–1865) (1865)
17.		Methodist*	Tailor			None	
18.	U.S. Military Acad.	Methodist	Soldier	Horatio Seymour Horace Greeley	(1868) (1872)	Schuyler Colfax Henry Wilson	(1869–1873) (1873–1875)
19.	Kenyon	Methodist*	Lawyer	Samuel J. Tilden	(1876)	William A. Wheeler	(1877–1881)
20.	Williams	Disciples of Christ	Lawyer	Winfield S. Hancock	(1880)	Chester A. Arthur	(1881)
21.	Union	Episcopalian	Lawyer			None	
22.		Presbyterian	Lawyer	James G. Blaine	(1884)	Thomas A. Hendricks	(1885)
23.	Miami	Presbyterian	Lawyer	Grover Cleveland	(1888)	Levi P. Morton	(1889–1893)
24.		Presbyterian	Lawyer	Benjamin Harrison	(1892)	Adlai E. Stevenson	(1893–1897)
25.	Allegheny College	Methodist	Lawyer	William J. Bryan	(1896, 1900)	Garret A. Hobart Theodore Roosevelt	(1897–1899) (1901)
26.	Harvard	Dutch Reformed	Author	Alton B. Parker	(1904)	Charles W. Fairbanks	(1905–1909)
27.	Yale	Unitarian	Lawyer	William J. Bryan	(1908)	James S. Sherman	(1909–1912)
28.	Princeton	Presbyterian	Educator	Theodore Roosevelt Charles E. Hughes	(1912) (1916)	Thomas R. Marshall	(1913–1921)
29.		Baptist	Editor	James M. Cox	(1920)	Calvin Coolidge	(1921–1923)
30.	Amherst	Congregationalist	Lawyer	John W. Davis	(1924)	Charles G. Dawes	(1925–1929)
31.	Stanford	Friend (Quaker)	Engineer	Alfred E. Smith	(1928)	Charles Curtis	(1929–1933)
32.	Harvard	Episcopalian	Lawyer	Herbert Hoover Alfred M. Landon Wendell L. Willkie Thomas E. Dewey	(1932) (1936) (1940) (1944)	John N. Garner Henry A. Wallace Harry S. Truman	(1933–1941) (1941–1945) (1945)
33.		Baptist	Businessman	Thomas E. Dewey	(1948)	Alben W. Barkley	(1949–1953)
34.	U.S. Military Acad.	Presbyterian	Soldier	Adlai E. Stevenson	(1952, 1956)	Richard M. Nixon	(1953–1961)
35.	Harvard	Roman Catholic	Author	Richard M. Nixon	(1960)	Lyndon B. Johnson	(1961–1963)
36.	Southwest Texas State	Disciples of Christ	Teacher	Barry M. Goldwater	(1964)	Hubert H. Humphrey	(1965–1969)
37.	Whittier	Friend (Quaker)	Lawyer	Hubert H. Humphrey George S. McGovern	(1968) (1972)	Spiro T. Agnew Gerald R. Ford**	(1969–1973) (1973–1974)
38.	Michigan	Episcopalian	Lawyer			Nelson A. Rockefeller§	(1974–1977)
39.	U.S. Naval Acad.	Baptist	Businessman	Gerald R. Ford	(1976)	Walter F. Mondale	(1977–1981)
40.	Eureka	Disciples of Christ	Actor	Jimmy Carter Walter F. Mondale	(1980) (1984)	George H. W. Bush	(1981–1989)
41.	Yale	Episcopalian	Businessman	Michael S. Dukakis	(1988)	Dan Quayle	(1989–1993)
42.	Georgetown	Baptist	Lawyer	George H. W. Bush Robert J. Dole	(1992) (1996)	Al Gore	(1993–2001)
43.	Yale	Methodist	Businessman	Al Gore	(2000)	Richard B. Cheney	(2001–)

*Church preference; never joined any church.
**Inaugurated Dec. 6, 1973, to replace Agnew, who resigned Oct. 10, 1973.
§Inaugurated Dec. 19, 1974, to replace Ford, who became President Aug. 9, 1974.

Roads to the White House

WORLD BOOK illustration by David Cunningham



Presidential election | Selection by Congress | Presidential succession

Presidential election

The chief road to the White House is the presidential election, which is held every four years. Political parties nominate their candidates for President and Vice President at national conventions. The nation's voters cast their ballots on Election Day to determine the presidential electors. The Electoral College, made up of the electors chosen by all the states and the District of Columbia, officially elects the President and Vice President.

Selection by Congress

If the Electoral College fails to give any candidate a majority, one of three procedures may be used. (1) The House of Representatives chooses the President from among the top three candidates. Each state's House delegation has only one vote, and the winner must receive a majority of the votes that are cast. (2) If the House fails to choose a President, the Vice President, chosen by the Electoral College or the Senate, becomes President. (3) If both houses fail to choose a President or Vice President, Congress shall by law deal with the situation. Congress would probably apply the terms of the Presidential Succession Act in that case. The Speaker of the House would then become President.

Presidential succession

If the President dies, resigns, or is removed from office, the Vice President becomes President. If the President becomes unable to perform the duties of office, the Vice President serves as acting President during the President's disability. Next in line to the presidency after the Vice President are the following government officials:

1. Speaker of the House
2. President *pro tempore* of the Senate
3. Secretary of state
4. Secretary of the treasury
5. Secretary of defense
6. Attorney general
7. Secretary of the interior
8. Secretary of agriculture
9. Secretary of commerce
10. Secretary of labor
11. Secretary of health and human services
12. Secretary of housing and urban development
13. Secretary of transportation
14. Secretary of energy
15. Secretary of education
16. Secretary of veterans affairs

provides that no one may be elected President more than twice. Nobody who has served as President for more than two years of someone else's term may be elected more than once.

Before the 22nd Amendment was approved in 1951, a President could serve an unlimited number of terms. Franklin D. Roosevelt held office longest. He was elected four times and served from March 1933 until his death in April 1945. President William H. Harrison served the shortest time in office. He died a month after his inauguration in 1841.

The Constitution allows Congress to remove a President from office. The President first must be *impeached* (charged with wrongdoing) by a majority vote of the House of Representatives. Then, the Senate, with the chief justice of the United States serving as presiding officer, tries the President on the charges. Removal from office requires conviction by a two-thirds vote of the Senate.

Only two Presidents, Andrew Johnson and Bill Clinton, have been impeached. Both remained in office, however, because the Senate failed to convict either man of the charges.

Salary and other allowances. Effective Jan. 20, 2001, the President receives a salary of $400,000 a year. The chief executive also gets $50,000 annually for expenses, plus allowances for staff, travel, and maintenance of the White House. Congress establishes all these amounts.

After leaving office, a President qualifies for a basic pension. In the early 2000's, the basic amount for a newly retiring President was $157,000 yearly. But a number of factors may affect the actual size of the pension. For example, it will be larger if the President has served in Congress. Other retirement benefits include allowances for office space, staff, and mailing expenses. Widowed spouses of former Presidents get an annual pension of $20,000.

Roads to the White House

The chief road to the White House is the presidential election held every four years. However, a person may become President of the United States several other ways as well.

The presidential election. Certain people frequently become leading candidates for the presidency because of their experience. They include the Vice President of the United States and governors of such large states as California and New York. A number of Vice Presidents and governors have become President.

Most top presidential candidates must first compete against fellow political party members to win the party's presidential nomination. The Democratic and Republican parties are the two main political parties in the United States. Each holds a national convention to nominate its presidential candidate. The conventions take place a few months before the presidential election.

The Democratic and Republican conventions are lively spectacles. Millions of Americans watch them on television. Delegates wave banners and cheer wildly to support their choice for President. See **Political convention**.

After the conventions, the presidential nominees campaign across the nation. Candidates for President face a number of challenges. They must raise millions of dollars for campaign expenses, attract many volunteers,



Wide World

The inauguration is held on January 20 after the election. This picture shows Chief Justice Earl Warren administering the presidential oath to John F. Kennedy in 1961. Looking on were departing President Dwight D. Eisenhower, *far left,* and future Presidents Lyndon B. Johnson, *second from right,* and Richard M. Nixon, *far right.*

and gain the support of voters throughout the country. The campaign continues until Election Day, the first Tuesday after the first Monday in November.

On Election Day, voters in each state and the District of Columbia mark a ballot for President and Vice President. This balloting is called the *popular vote.* The popular vote does not directly decide the winner of the election. Instead, it determines the delegates who will represent each state and the District of Columbia in the Electoral College. These delegates officially elect the President and Vice President.

The Electoral College has 538 delegates, each of whom casts one electoral vote. To be elected President, a candidate must win a majority, or 270, of the electoral votes. Each state has as many electoral votes as the total of its representatives and senators in Congress. The District of Columbia has three electoral votes.

The Electoral College voting takes place in the December following the presidential election. The results are announced in January. But the public usually finds out who the President will be a few hours after polls close on Election Day. This is because the candidate who gets the most popular votes in a state will receive by custom or law all the state's electoral votes. Thus, the press can forecast the winner.

The winner of the nationwide popular vote nearly always receives a majority of the electoral votes and becomes President. But the Electoral College has elected Presidents who lost the popular vote. These Presidents were Rutherford B. Hayes in 1876, Benjamin Harrison in 1888, and George W. Bush in 2000. A fourth President, John Quincy Adams, also lost the popular vote. But Adams was elected President by the House of Representatives after no candidate had received a majority of the electoral votes in the election of 1824. Ronald Reagan received the greatest number of electoral votes of any President—525 in 1984. See **Electoral College**.

The inauguration is the ceremony of installing the new or reelected President in office. It is held at noon on January 20 after the election. Up to 100,000 spectators attend the inauguration, which usually takes place outside the U.S. Capitol in Washington, D.C. Millions of other Americans see the event on television.

The highlight occurs when the new President takes the oath of office from the chief justice of the United States. With right hand raised and left hand on an open Bible, the new President says: "I do solemnly swear (or affirm) that I will faithfully execute the office of President of the United States, and will to the best of my ability, preserve, protect and defend the Constitution of the United States."

Other roads to the White House. A person may become President in other ways besides winning the presidential election. These procedures are established by Article II of the Constitution; the 12th and 20th amendments; and the Presidential Succession Act.

Article II provides that the Vice President becomes President whenever the President dies, resigns, is removed from office, or cannot fulfill the duties of the presidency. Nine Vice Presidents became President by filling a vacancy. One of them, Gerald R. Ford, followed an unusual route to the White House. President Richard M. Nixon nominated him to succeed Spiro T. Agnew, who had resigned as Vice President in 1973. In 1974, Nixon resigned as President, and Ford succeeded him. Ford was the only President who was not elected to either the vice presidency or the presidency.

The 12th Amendment permits Congress to act if no candidate for President wins a majority of the electoral votes. Then, the House of Representatives chooses the President. Each state delegation casts one vote. The House has elected two Presidents, Thomas Jefferson in 1801 and John Quincy Adams in 1825.



Office of the Curator, The White House

In the Cabinet Room of the White House, the President meets with the Cabinet and the National Security Council.

The 20th Amendment allows leaders of the party of the popular-vote winner to select a new presidential candidate if the winner dies before the Electoral College meets. The college would then vote on that selection. If the popular-vote winner dies after the college meets but before the inauguration, the winning candidate for Vice President becomes President. Neither of these provisions has ever been applied.

The Presidential Succession Act permits other high government officials to become President if vacancies exist in both the presidency and the vice presidency. Next in line is the speaker of the House. Then comes the *president pro tempore* (temporary president) of the Senate, usually the majority party member who has served the longest in the Senate. Next are members of the presidential advisory group known as the Cabinet, with the secretary of state first. The Succession Act has never been applied. See **Presidential succession**.

The executive branch

The President heads the executive branch of the federal government. This branch consists of the Executive Office of the President, 14 executive departments, and about 80 independent agencies.

The Executive Office of the President consists of a number of agencies that work directly for the chief executive. One of them, the White House Office, includes the President's physician, secretaries, and a number of close, influential aides known as *presidential assistants*. See **Presidential assistant**.

The other Executive Office agencies also provide ideas and suggestions concerning many national and international issues. These agencies include the Council of Economic Advisers, Council on Environmental Quality, National Security Council, Office of Administration, Office of Management and Budget, Office of National Drug Control Policy, Office of Policy Development, Office of Science and Technology Policy, and Office of the United States Trade Representative. Franklin D. Roosevelt created the Executive Office in 1939.

The executive departments directly administer the federal government. They are the departments of (1) State, (2) the Treasury, (3) Defense, (4) Justice, (5) the Interior, (6) Agriculture, (7) Commerce, (8) Labor, (9) Health and Human Services, (10) Housing and Urban Development, (11) Transportation, (12) Energy, (13) Education, and (14) Veterans Affairs. In 2002, President George W. Bush proposed the creation of a 15th executive department, the Department of Homeland Security.

The heads of all but one of the executive departments are called *secretaries*. The head of the Justice Department is the *attorney general*. The department heads belong to the President's Cabinet (see **Cabinet**). The President nominates the department heads. All the appointments require approval of the Senate.

The independent agencies administer federal programs in many fields. These fields include aeronautics and space, banking, communications, farm credit, labor relations, nuclear energy, securities, small business, social security, and trade.

Independent agencies may issue rules, enforce penalties, and administer programs that have far-reaching effects on American life. Some independent agencies are known as *regulatory agencies*. Important regulatory agencies include the Federal Reserve System, the Federal Communications Commission, and the Equal Employment Opportunity Commission. The President picks the heads of nearly all the independent agencies. These people require the consent of the Senate.

Roles of the President

The only roles that the Constitution clearly assigns to the President are those of chief administrator of the nation and commander of its armed forces. But court decisions, customs, laws, and other developments have greatly expanded the President's responsibilities and powers. Today, the President has seven basic roles: (1) chief executive, (2) commander in chief, (3) foreign policy director, (4) legislative leader, (5) party head, (6) popular leader, and (7) chief of state.

Chief executive. As chief executive, the President has four main duties. They are (1) to enforce federal laws, treaties, and federal court rulings; (2) to develop federal policies; (3) to prepare the national budget; and (4) to appoint federal officials.

The President uses a variety of powers to carry out administrative duties. Federal laws give the President *emergency powers*—that is, special authority to prevent or end a national emergency. For example, the Taft-Hartley Act allows the President to delay a labor strike for 80 days if it might endanger "national health or safety." The President also may issue *executive orders*—that is, directions, proclamations, or other statements that have the force of laws. They require no action by Congress. One of the most famous executive orders was the Emancipation Proclamation issued by Abraham Lincoln in 1863, during the American Civil War. It declared freedom for all slaves in areas under Confederate control.

The Office of Management and Budget, part of the Executive Office, helps the President plan the federal budget. Presidents often use their budgets to shape key programs. Lyndon B. Johnson did so in the mid-1960's to develop his War on Poverty program.

The President nominates Cabinet members, Supreme



Library of Congress

Abraham Lincoln quickly built up the Union Army after the Civil War began in 1861. After the Battle of Antietam in 1862, he visited General George B. McClellan on the battlefield, *shown here.*

Court justices, and other high federal officials. All such top appointments require Senate approval. The President can appoint a number of personal aides and advisers and can fill hundreds of lower jobs in the executive branch without Senate approval.

The Constitution also allows the President to issue *reprieves* and *pardons* for crimes against the United States, except in impeachment cases. A reprieve delays the penalty for a crime. A pardon frees the offender from a sentence or the possibility of a sentence.

Commander in chief. The President's main duties as commander of the nation's armed services are to defend the country during wartime and to keep it strong during peacetime. The chief executive appoints all the nation's highest military officers and helps determine the size of the armed forces. Only the President can decide whether to use nuclear weapons.

The President shares some military powers with Congress. Top appointments in the armed services require congressional approval. Major military expenses and plans to expand the armed forces also need the consent of Congress. Only Congress can declare war. But Presidents have sent American troops into conflicts that were equal to war though none was declared. In 1950, for example, Harry S. Truman ordered U.S. troops to fight in South Korea. The Korean War (1950-1953) was officially only a "police action."

Congress generally allows the President to exercise broad powers in wartime. During World War II (1939-1945), Franklin D. Roosevelt created many emergency agencies, took control of American manufacturing plants, and even imprisoned American citizens of Japanese descent.

Foreign policy director. The Constitution gives the President power to appoint ambassadors, make treaties, and receive foreign diplomats. The chief executive may refuse to recognize a newly formed foreign government. The President also proposes legislation dealing with foreign aid and other international activities.

Treaties and ambassadorial appointments require approval of the Senate. The President may also make *executive agreements* with foreign leaders. These agreements resemble treaties but do not need Senate approval.

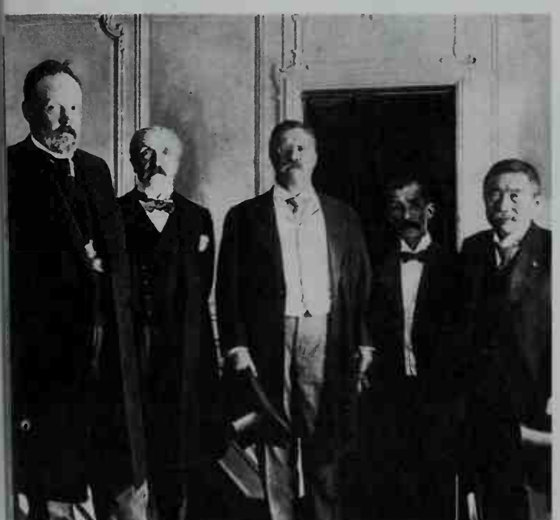
Many Presidents have allowed their secretaries of state to direct U.S. foreign policy. But Woodrow Wilson, Franklin D. Roosevelt, and others have mainly relied on their own judgment in this area.

Some Presidents have helped settle disputes between foreign nations. Theodore Roosevelt and Wilson were among the first Presidents to serve as peacemakers in foreign conflicts. Roosevelt won the Nobel Peace Prize for helping end the Russo-Japanese War (1904-1905). Wilson helped work out the peace treaty that ended World War I (1914-1918).

Legislative leader. The President greatly influences the development of many laws passed by Congress. At the beginning of each session of Congress, the chief executive delivers a State of the Union address to the lawmakers. In this message, the President discusses the major problems facing the nation and recommends a legislative program to solve them. The President also gives Congress detailed plans for new legislation at other times during the year.

Cabinet officers and other presidential aides work to win congressional support for the President's programs. However, the President also may become involved in a struggle over a key bill. In such cases, the President may speak to members of Congress several times to win their backing. This activity requires shrewd bargaining and in many cases fails in spite of the President's influence.

The Constitution allows the President to veto any bill passed by Congress. If both the House and the Senate repass the vetoed bill by a two-thirds majority, the bill becomes law despite the President's disapproval. But Congress has overturned only about 4 percent of all vetoes.



Wide World

heodore Roosevelt met with Russian and Japanese delegates 1905 and helped end the Russo-Japanese War. In 1906, he beıme the first American to win the Nobel Peace Prize.



United Press Int.

Franklin D. Roosevelt explained his policies in informal radio reports that became known as "fireside chats," *shown here.* In 1939, he became the first President to appear on television.

Party head. As leader of a political party, the President helps form the party's positions on all important issues. The President hopes these positions will help elect enough party members to Congress to give the party a majority in both the House and the Senate. Such a strong party makes it easier to pass the President's legislative program.

However, Presidents cannot always control members of their party in Congress. Senators and representatives owe their chief loyalty to the people in their state and local district. They may vote against a bill favored by the President if it meets with opposition at home.

Presidents try to win the support of legislators in several ways. They often use *patronage power,* the authority to make appointments to government jobs. For example, a President can reward a loyal supporter by approving that person's choice for a federal judge. A President also may campaign for the reelection of a faithful party member or promise to approve a federal project that will benefit a legislator's home district.

Popular leader. The President and the American people have a special relationship. The people rely on the chief executive to serve the interests of the entire nation ahead of those of any state or citizen. In turn, the President depends on public support to help push programs through Congress. The President seeks such support by explaining the issues and by showing the confidence and determination to deal with problems.

The President uses many methods to communicate with the public and provide strong national leadership. Woodrow Wilson pioneered the use of regular presidential press conferences to mold public opinion and to rally support. Franklin D. Roosevelt addressed the nation over radio in his "fireside chats." He was also the first President to speak on television. Since the 1960's, Presidents have favored the use of televised addresses from the White House to reach large audiences.

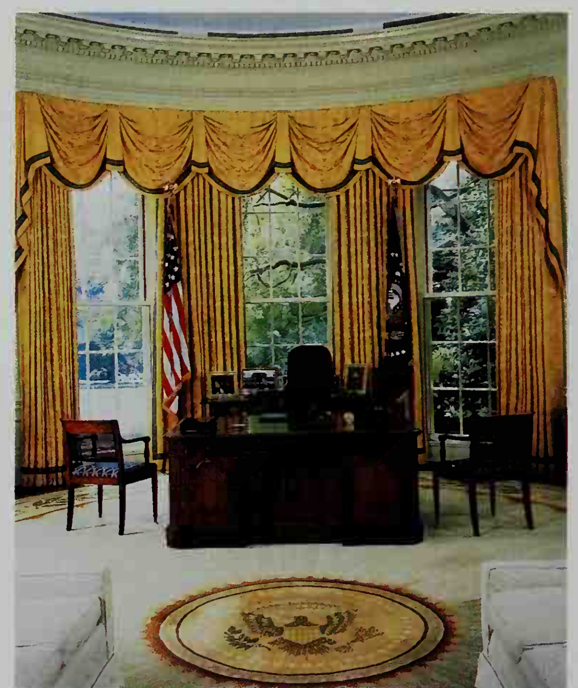


Dwight D. Eisenhower Library

Dwight D. Eisenhower performed a traditional activity as the nation's chief of state when he threw out the first ball to open the 1953 baseball season in Washington, D.C.

Chief of state. As the foremost representative of the U.S. government, the President is expected to show pride in American achievements and traditions. In this role, the President attends historical celebrations, dedicates new buildings and national parks, and may throw out the first ball of the professional baseball season. The President also presents awards to war heroes and invites distinguished Americans to the White House.

In addition, the chief executive greets visiting foreign officials and often hosts formal White House dinners for them. The President also represents the United States in visits to other countries.



© White House Collection from The White House Historical Association

The President's office, an oval-shaped room called the Oval Office, is in the west wing of the White House. The President meets here with many government officials and receives frequent briefings on national and world affairs.

The life of the President

The President is almost always busy. During a typical day, the chief executive attends several meetings and social affairs and may meet 100 or more people. The President works and lives in the White House in Washington, D.C., but makes many outside appearances and spends much time traveling.

The White House. The President's headquarters is the Oval Office, an oval-shaped room in the White House. There, the chief executive meets congressional leaders, foreign officials, and representatives of various groups. The President also spends much time in the Oval Office studying reports from aides and agencies.

The presidential family's main living quarters are on the second floor of the White House. The family also can relax in the mansion's swimming pool and at its bowling lanes and motion-picture theater. The White House grounds have some beautiful gardens.

In spite of its beauty and comfort, however, the White House lacks privacy. Every week, thousands of visitors tour the rooms that are open to the public. Partly as a result, most Presidents enjoy recreation outside the White House.



Nixon Project, National Archives

Camp David is the official retreat of the President of the United States. It lies in a wooded mountain area in Maryland.

Recreation. The President often spends weekends at Camp David, a retreat in the Maryland mountains that is reserved for the nation's leader. Through the years, Presidents have favored various ways to relax. Theodore Roosevelt boxed, hiked, and hunted big game. Warren G. Harding played poker, and Dwight D. Eisenhower played golf. Lyndon B. Johnson and Ronald Reagan enjoyed horseback riding.

The President's family generally attracts wide interest. The wedding of a President's child is a major news event. An interesting relative also draws much attention. Even unimportant activities of members of the President's family sometimes appear in the newspapers.



© Mark Wilson, Getty Images

The president hosts various social functions. This picture shows President George W. Bush, *right,* and Mexican President Vicente Fox Quesada with their wives at a White House dinner.

Some Presidents have had children who helped make the White House cheerful and lively. John Tyler had 15 children, more than any other President. Daughters of seven Presidents were married in the White House. Grover Cleveland was the only President who had a child born in the White House.

Guarding the President. The United States Secret Service guards the President at all times. In addition, agents of the Secret Service continually check the President's food, surroundings, and travel arrangements.

At various times, the President travels in an official car, a private airplane, or a U.S. Navy ship. The chief executive usually flies long distances in a reserved jet called *Air Force One.*

Even though U.S. Presidents get tight protection, four have been assassinated while in office. They were Abraham Lincoln in 1865, James Garfield in 1881, William McKinley in 1901, and John F. Kennedy in 1963. Others have survived attempted assassinations, including Harry S. Truman, Gerald R. Ford, and Ronald Reagan.

A day in the life of the President. The President might begin a typical day by reading a few newspapers. A breakfast conference might follow with such top aides as the press secretary and the White House chief of staff. In the Oval Office, the President signs documents and reads letters, reports, and proposed legislation. Later in the morning, the President might discuss plans with congressional leaders or meet with the Vice President. In the afternoon, the President might see people from various organizations. The President also might take part in a bill-signing ceremony, officially signing into law an act passed by Congress.

In the evening, the President sometimes attends a social function. The White House might host a formal dinner for a foreign official. While dining, the leaders might discuss trade problems, environmental protection, or other issues. The President might spend the late evening reading, perhaps a speech scheduled for the next day or a report on a new foreign aid program.

Development of the presidency

The founding of the presidency. During and immediately after the Revolutionary War in America (1775-1783), the U.S. government operated under laws called the Articles of Confederation. The Articles gave the national government little authority over the states. Most Americans agreed that the nation needed to strengthen its federal government. In 1787, a group of state leaders gathered in Philadelphia to revise the Articles of Confederation. Instead, they wrote an entirely new document—the Constitution of the United States.

Under the Articles, the chief officer presiding over Congress had been called the President, and that title was chosen for the leader of the new government. The Constitution's authors described the presidency in fairly general language because they knew the nation's respected wartime leader, George Washington, would be the first President. They expected Washington to shape the responsibilities of the office for future Presidents.

Washington brought extraordinary courage, prestige, and wisdom to the U.S. presidency. In 1793, he kept the young nation out of a war between Britain and France. In 1794, Washington used federal troops to end the

Whiskey Rebellion, a tax protest in the state of Pennsylvania. This action helped establish the federal government's authority to enforce federal laws in the states.

Strengthening the office. During the early and mid-1800's, the nation had several bold and imaginative Presidents. They interpreted the Constitution in new ways and greatly increased the power of the presidency. One of these leaders was Thomas Jefferson, the third President. Many scholars consider Jefferson the most brilliant person ever to have served in the White House.

Jefferson raised a constitutional question when he approved a treaty to buy the Louisiana Territory from France in 1803. The purchase almost doubled what was then the area of the United States. The Constitution did not specifically give the President power to buy new territory. But Jefferson decided that the purchase was constitutional under his treaty-making power.

Andrew Jackson strengthened the President's role as the nation's popular leader. In July 1832, Jackson vetoed a bill to renew the charter of the Second Bank of the United States. Jackson and many other Americans viewed the bank as a dangerous monopoly and criticized its failure to establish a reliable currency. Later in 1832, South Carolina declared federal tariff laws unconstitutional and refused to collect tariffs at its ports. Jackson declared that no state could cancel a federal law. The President received congressional approval to use federal troops in order to collect the tariffs. Jackson's actions helped force South Carolina to end its rebellion.

The Civil War began in 1861, when Southern forces attacked Fort Sumter. Abraham Lincoln ordered a military draft, blockaded Southern ports, and spent funds without congressional approval. He knew he had used powers the Constitution reserved for Congress. But he believed his actions were needed to save the Union.

The decline of the presidency. After the Civil War ended in 1865, Congress moved quickly to increase its influence in the government. A power struggle broke out between Congress and Andrew Johnson. This struggle led to Johnson's impeachment by the House of Representatives. The prestige of the presidency was damaged, but it was saved from total destruction because the Senate failed, by one vote, to convict Johnson.

Few strong Presidents emerged during the late 1800's. Most Presidents of the period accepted the view that Congress, not the chief executive, had the responsibility to set the nation's basic policies.

The rebirth of presidential leadership. The United States became a world power during the late 1800's and early 1900's. This development helped bring increased power to the President. In the Spanish-American War (1898), the United States took control of Guam, the

Interesting facts about Presidents

Who was the only President who did not win election to either the office of Vice President or President? Ford.
Who was the only President who had served as Speaker of the House? Polk.
Who was the only President to serve two nonconsecutive terms? Cleveland.
Who held the first regular presidential press conferences? Wilson.
Which President was sworn into office on an airplane? Lyndon B. Johnson.
Who was the only person to serve as both President and chief justice? Taft.
Which President was sworn into office by a woman? Lyndon B. Johnson by Judge Sarah T. Hughes.
Four Presidents were elected whose closest opponent received more popular votes. Who were the Presidents? John Quincy Adams, election of 1824; Hayes, 1876; Benjamin Harrison, 1888; and George W. Bush, 2000.
Who was the first President to visit a foreign country while in office? Theodore Roosevelt.
Which Presidents are buried in Arlington National Cemetery? Taft and Kennedy.
Who were the only grandfather and grandson who both served as President? William H. Harrison and Benjamin Harrison.
Who were the only Presidents to be sworn into office by a former President? Coolidge and Hoover (by Taft).
Which President never married? Buchanan.
Two sons of former Presidents became President themselves. Who were the sons and who were their fathers? John Quincy Adams, son of John Adams, and George W. Bush, son of George H. W. Bush.
Which two former Presidents died on the same day? John Adams and Jefferson.
Which Presidents lived past the age of 90? John Adams, Hoover, and Reagan.
Which President lived the shortest time? Kennedy, 46 years.
Who was the only former Vice President who became President but did not succeed the President under whom he served? Nixon.
Which President had the most children? Tyler, 15.
Who was the first President to live in the White House? John Adams.
Who was the first President to be inaugurated in Washington, D.C.? Jefferson.
Who was the first President to speak on radio? Wilson.
Who was the first President to speak on television? F. D. Roosevelt.
What two Presidents died in the White House? W. H. Harrison and Taylor.
Which President served the shortest time in office? W. H. Harrison, one month, 1841.
Which President served the longest? F. D. Roosevelt, 12 years, 1 month, 8 days.
Which President received the greatest number of electoral votes? Reagan in 1984, 525.
Which Presidents signed the Constitution? Washington, Madison.
Who was the only President who had a child born in the White House? Cleveland, in 1893.
Which Presidents were assassinated? Lincoln, Garfield, McKinley, Kennedy.
Which other Presidents died in office? W. H. Harrison, Taylor, Harding, Franklin D. Roosevelt.
Which Presidents died on the Fourth of July? Jefferson, 1826; John Adams, 1826; and Monroe, 1831.
Who was the first President born after the adoption of the U.S. Constitution? Tyler.
Who was the first President to ride on a railroad train? Jackson.
Who was the only President to resign? Nixon.
Which Presidents served as university presidents before their election to the U.S. presidency? Wilson (Princeton) and Eisenhower (Columbia).
Who was the first President nominated by a national political convention? Jackson.
Who was the youngest person ever to become President? T. Roosevelt, 42.
Who was the youngest person ever elected President? Kennedy, 43.
Who was the oldest person ever elected President? Reagan, 73 years and 274 days when he was elected to his second term.

Philippines, and Puerto Rico. To protect these interests, Theodore Roosevelt built up U.S. military forces. He also warned European nations against interfering in Latin America. Roosevelt broadened the scope of executive power at home by leading a fight for reforms that limited the power of great corporations.

Woodrow Wilson enlarged the presidency during World War I (1914-1918). After the United States entered the conflict in 1917, Wilson rallied public support for the war effort. He won widespread praise for his pledge to help make the world safe for democracy. After the war, he led the drive to set up the League of Nations, an international organization dedicated to maintaining peace.

Perhaps no one expanded the powers of the presidency as much as Franklin D. Roosevelt. He became President during the Great Depression of the 1930's and took extraordinary measures to combat the severe business slump. Roosevelt won public acceptance of his view that the federal government should play a major role in the economy. Largely as a result of strong popular support, he got Congress to adopt a far-reaching program called the New Deal. This program created work for millions of Americans and strengthened the President's role as the nation's legislative leader.

The rapid growth of U.S. military strength during World War II (1939-1945) further increased the influence of the presidency in world affairs. Harry S. Truman's decision to use atomic bombs against Japan during the war showed the tremendous authority of the President.

Another example of this authority occurred in the Cuban missile crisis in 1962. In that crisis, John F. Kennedy carried out negotiations that led to the withdrawal of Soviet missiles from Communist Cuba. The Soviet Union had placed nuclear missiles in Cuba capable of striking U.S. cities. Kennedy demanded the missiles' removal and announced a naval blockade of Cuba. Several days later, the Soviets withdrew their missiles after the U.S. publicly promised to withdraw its nuclear missiles from Turkey and privately agreed not to invade Cuba.

The Vietnam War. The presidency lost much of its prestige during the Vietnam War (1957-1975). Lyndon B. Johnson, who became President in 1963, believed that non-Communist South Vietnam had to be defended against local Communist rebels and Communist North Vietnam. In 1964, Congress allowed him "to take all necessary measures" to protect U.S. bases in South Vietnam.

During the late 1960's and early 1970's, Johnson and his successor, Richard M. Nixon, sent hundreds of thousands of U.S. troops to support South Vietnam. Many Americans opposed United States participation in the Vietnam War. They argued that both Johnson and Nixon had abused presidential powers and misled Congress.

The Watergate scandal further damaged public regard for the presidency. It involved burglary, wiretapping, and other illegal activities designed to help Nixon win reelection in 1972. Attempts by Nixon's aides to cover up many of the activities led to an investigation by the House of Representatives. In 1974, the House Judiciary Committee recommended that Nixon be impeached.

That same year, Nixon lost an appeal to the Supreme Court involving the President's *executive privilege*—the right to keep records secret. The court ruled that executive privilege is not unlimited. It ordered Nixon to release recordings of conversations said to contain evidence for a criminal case in the Watergate scandal. By then, Nixon had lost nearly all support in Congress and faced possible impeachment. He resigned as President on Aug. 9, 1974, and was succeeded by Vice President Gerald R. Ford. No other President has ever resigned.

Many Americans thought Nixon had violated federal laws and wanted him brought to trial. The nation became further divided in September 1974, when Ford pardoned Nixon for all federal crimes Nixon may have committed as President.

The impeachment of Bill Clinton. In 1998, the House impeached President Bill Clinton for perjury and obstruction of justice. The House charged Clinton with lying to a grand jury that was investigating an extramarital affair he had while in office. Other charges included hindering the investigation by lying to his aides and by





Brown Bros.

Presidential election campaigns have changed over the years. Warren G. Harding campaigned from his front porch in Marion, Ohio, in 1920, *left.* President Harry S. Truman toured the nation in a special railroad car during a "whistle-stop" campaign in 1948, *right.*

encouraging others to lie and conceal evidence on his behalf. The Senate acquitted Clinton in 1999.

The presidency today is still strong and important. This is largely because the United States has powerful armed forces and ranks as a leader of the democracies. In addition, the president's ability to reach huge audiences on television adds to the prestige of the office.

Americans look to the president to build morale, recruit talented officials, and explain complex issues. They also expect the chief executive to champion the rights of all Americans regardless of their age, color, political party, religion, region, or sex. At the same time, some Americans dislike the great size and power of the national government and want the president to reduce federal influence over state and local affairs.

Congress and the Supreme Court sometimes act to prohibit or limit actions that they consider a misuse of presidential power. But such challenges have halted the expansion of presidential authority only for limited periods. The presidency will continue to have its ups and downs. But it will remain, as John F. Kennedy once said, "the vital center of action in our whole scheme of government."

Thomas E. Cronin

Related articles in *World Book.* See the separate biographies of each president. Other articles include:

Roads to the White House

Election
Election campaign
Electoral College
Political convention
Political party
Presidential succession
Primary election (The presidential primary)

The executive branch

Constitution of the United States (Article II)
Economic Advisers, Council of
Management and Budget, Office of
National Security Council
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Vice President of the U.S.

Other related articles

Address, Forms of
Atchison, David Rice
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Hail to the Chief
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Impeachment
Presidential libraries
Presidents' Day
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White House hostesses

Outline

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Questions

What are the qualifications for a president?
Who succeeds a president who dies in office?
What are the executive departments?
How did Theodore Roosevelt enlarge the presidency?
What challenges does a presidential candidate face?
What are *executive orders*?
What was the Watergate scandal?
What is the president's *patronage power?*
In what ways does the president usually travel?
What are the seven basic roles of the president?

Additional resources

Level I

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Presidential assistant is a person who performs special duties for the president of the United States. The most important assistants work directly for and with the president. Most assistants serve as part of the White House Office, a division of the Executive Office of the President (see **President of the United States** [The Executive Office of the President]).

Presidential assistants aid in nearly every aspect of the president's work. Some help formulate foreign policy. Others help design domestic programs. They provide information and suggestions that help the president make decisions. Others write speeches and develop legislation to propose to Congress. The press secretary handles relations with the media. Assistants recommend appointments to certain government positions. They also help decide which individuals or groups should meet personally with the president.

The modern system of presidential assistants began with President Franklin D. Roosevelt in the late 1930's. The president's responsibilities have grown since then, and so have the number and power of presidential aides. Some critics believe powerful assistants reduce the authority of Cabinet officials. Other observers argue that many issues are broader than the responsibilities of any Cabinet official or executive department, and so the president needs strong aides to help decide them.

Presidents sometimes claim *executive privilege* for their assistants. This doctrine protects assistants from having to testify before Congress, unlike Cabinet offi-

cials, who are required to do so. However, it does not necessarily protect assistants from having to testify in criminal investigations. Critics of the executive privilege doctrine hold that it disturbs the balance of power between the executive and legislative branches by denying Congress information it needs to do its job. Defenders argue that assistants must have such privacy to serve as confidential advisers to the president. I. M. Destler

Related articles in *World Book* include:

Adams, Sherman
Baker, James Addison, III
Brzezinski, Zbigniew K.
Clifford, Clark M.
Hopkins, Harry Lloyd
House, Edward M.
Kissinger, Henry A.
Laird, Melvin R.
Moynihan, Daniel P.
O'Brien, Lawrence F.
Schlesinger, Arthur M., Jr.

Presidential libraries collect documents and other items associated with a former United States president. There are 12 presidential libraries. The National Archives administers 10 of them: the George Bush Library in College Station, Texas; the Jimmy Carter Library in Atlanta, Georgia; the Dwight D. Eisenhower Library in Abilene, Kansas; the Gerald R. Ford Library in Ann Arbor, Michigan; the Herbert Hoover Library in West Branch, Iowa; the Lyndon Baines Johnson Library in Austin, Texas; the John Fitzgerald Kennedy Library in Boston; the Ronald Reagan Library in Simi Valley, California; the Franklin D. Roosevelt Library in Hyde Park, New York; and the Harry S. Truman Library in Independence, Missouri. President Bill Clinton announced in 1997 that his presidential library would be in Little Rock, Arkansas. In 2000, Congress approved funding for the Abraham Lincoln Library, to be built in Springfield, Illinois.

The National Archives also administers the official records of the presidency of Richard M. Nixon. These records are kept in Alexandria, Virginia.

The two presidential libraries not managed by the National Archives are the Richard Nixon Library in Yorba Linda, California, and the Rutherford B. Hayes Library in Fremont, Ohio. The Richard Nixon Library and Birthplace Foundation owns and operates the Nixon Library. The Hayes Library is owned by the state of Ohio and operated by the Rutherford B. Hayes Presidential Center.

Many people visit a presidential library to study its books, newspapers, films, photographs, sound recordings, videotapes, and other documents. Each library also includes a museum with exhibits that tell the story of the life and career of the president. The museum of the Gerald R. Ford Library is a separate facility in Grand Rapids, Michigan. John Fawcett

Presidential Medal of Freedom. See Medals, decorations, and orders (Civilian awards; table).

Presidential succession is provided for by Article II and Amendments 20 and 25 of the United States Constitution. Article II states that the vice president shall assume the duties and powers of the president if the president is removed from office, dies, resigns, or is unable to carry out the duties of the office.

Amendment 20, adopted in 1933, provides that the vice president-elect becomes president if the president-elect dies before the term begins but after the Electoral College has met. The Electoral College is a group of representatives chosen by the voters to officially elect the president. If the president-elect dies before the Electoral College meets, the national committee of the victorious political party would select a new candidate. Normally, this candidate would be the vice president-elect, though it need not be. After such a selection, however, the college would vote on that candidate.

If both the president and vice president should die or become disqualified, succession is determined by the Presidential Succession Act of 1947. This law states that the speaker of the House, and then the president *pro tempore* of the Senate, are next in succession. The Cabinet follows in this order:

1. Secretary of state
2. Secretary of the treasury
3. Secretary of defense
4. Attorney general
5. Secretary of the interior
6. Secretary of agriculture
7. Secretary of commerce
8. Secretary of labor
9. Secretary of health and human services
10. Secretary of housing and urban development
11. Secretary of transportation
12. Secretary of energy
13. Secretary of education
14. Secretary of veterans affairs

Under the 1947 law, the secretaries of agriculture, commerce, and labor were added, and the secretary of defense replaced the secretary of war. In 1965, Congress added the secretaries of health, education, and welfare (now health and human services); and housing and urban development to presidential succession. The secretary of transportation was added in 1966, secretary of energy in 1977, secretary of education in 1979, and secretary of veterans affairs in 1989. In 2002, President George W. Bush proposed the creation of a 15th executive department, the Department of Homeland Security. No Cabinet member may become acting president unless the member is a citizen and at least 35 years old. If the member who would logically succeed to the presidency is less than 35, the presidency passes to the next eligible member.

Amendment 25, ratified in 1967, permits the president to nominate a vice president whenever a vacancy exists in that office. The nominee would take office when confirmed by a majority vote of both houses of Congress. The amendment also establishes procedures for temporarily relieving a president who is unable to perform official duties because of an illness or for any other reason. The vice president would become acting president at such times. In 1973, Gerald R. Ford became the first person chosen vice president under Amendment 25. He was nominated by President Richard M. Nixon following the resignation of Vice President Spiro T. Agnew. Ford became president in 1974, after Nixon resigned.

Thomas E. Cronin

See also **Cabinet; Constitution of the United States** (Amendments 20 and 25).

Presidents' Day is an annual holiday observed in the United States to honor the nation's presidents, especially George Washington and Abraham Lincoln. It is celebrated on the third Monday in February. The birthdays of Washington and Lincoln fall near or on the holiday. Washington, the nation's first president, was born on Feb. 22, 1732, according to the calendar we now use. Lincoln, who served as president during the American Civil War (1861-1865), was born on Feb. 12, 1809.

A federal holiday called Washington's Birthday also occurs on the third Monday in February. It became a le-

gal public holiday in 1971. Later, many states adopted Presidents' Day instead, to honor not only Washington, but other presidents as well, especially Lincoln. Presidents' Day is sometimes called Washington-Lincoln Day.

On Presidents' Day, banks, government offices, libraries, and schools close. Most businesses stay open. Many stores hold Presidents' Day sales. Jack Santino

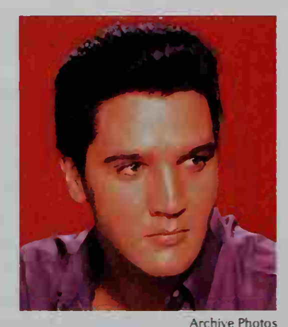
Presley, Elvis (1935-1977), was one of the first American stars of rock music and perhaps the greatest. His popularity continued after his death, rising to almost legendary status.

Elvis Aron Presley was born on Jan. 8, 1935, in Tupelo, Mississippi. During his childhood in Tupelo, he was exposed to the music that shaped his singing style—gospel, country music, and rhythm and blues. When he was 13 years old, he moved with his family to Memphis, Tennessee. At the age of 18, while driving a truck for a living, Presley entered the Sun Records studio run by Sam Phillips in Memphis. Presley stopped in to record two songs, presumably for his mother's birthday. Phillips signed him to a recording contract. Presley's 1954 recording "That's All Right, Mama" became a local hit.

Presley's records sold so well that he attracted the interest of national music companies, especially RCA. Encouraged by Colonel Tom Parker, Presley's manager, RCA bought the singer's contract from Sun Records. Using the enormous resources of RCA, Parker made Presley a national phenomenon. On Sept. 9, 1956, a record number of people watched Presley sing on the Ed Sullivan television variety show. Presley's early hits for RCA included "Heartbreak Hotel" (1956), "Don't Be Cruel" (1956), "Love Me Tender" (1956), "All Shook Up" (1957), "Teddy Bear" (1957), "Loving You" (1957), "Jailhouse Rock" (1957), and "It's Now or Never" (1960). Presley also launched a motion-picture career, beginning with *Love Me Tender* (1956). He made 32 other films.

Presley was particularly popular with teen-agers, who loved his style as well as his music. In particular, they reacted to his sexiness, especially the suggestive way he swiveled his hips as he sang. However, his style also aroused a storm of criticism. Some towns banned his live concerts, and television programs began showing him only from the waist up.

In 1958, Presley was inducted into the United States Army. He spent two years in the Army, primarily in Germany. There he met 14-year-old Priscilla Beaulieu. They were married in 1967 and had a daughter, Lisa Marie, born in 1968. They were divorced in 1973. After his discharge from the military, Presley resumed his motion-picture career and gave up making live appearances. In 1968, believing that the music business was passing him by, he prepared a comeback on television. The program, his first live performance in almost eight years, was so popular that Presley resumed touring. He also recorded such hit songs as "In the Ghetto" (1969) and "Suspicious Minds" (1969). His audience broadened to include older fans in addition to teen-agers.



Archive Photos

Elvis Presley

Presley had made an unsuccessful appearance at a Las Vegas hotel in 1956. He returned to the city in 1969, where he was an enormous success. Until his death, he was the most popular entertainer in Las Vegas.

At first, Presley's return to live performances seemed to energize him. But the pressures of being the "king" of rock music undermined his health. He began taking pills to sleep, to wake up, and to keep his weight down. He died at Graceland, his home in Memphis, at the age of 42. Many people believe drugs hastened his early death.

Since his death on Aug. 16, 1977, Presley has become an even more celebrated figure. The devotion of his fans has become almost religious in its intensity. Graceland has become a major international tourist attraction.

David Rubel

See also **Mississippi** (Places to visit); **Rock music** (The emergence of rock 'n' roll); **Graceland; Tennessee** (Places to visit).

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Pre-Socratic philosophy is a term for the theories developed by Greek philosophers from about 600 B.C. to 400 B.C. These philosophers are called *pre-Socratic* because most of them preceded Socrates, the famous philosopher of Athens. The pre-Socratics tried to understand and explain the natural universe in terms of natural principles. They developed conflicting theories but shared a basic interest in the origin and natural processes of the universe. The pre-Socratics laid the foundation for the work of later philosophers.

Scholars know little about the pre-Socratics. Their knowledge comes mainly from fragments of pre-Socratic writings and the works of later writers.

The first pre-Socratics lived in Miletus, a Greek city in Asia Minor, during the 500's B.C. These philosophers believed the universe originated from, and is composed of, one basic substance. The first known pre-Socratic, Thales, taught that water was this substance. Another member of the group, Anaximander, thought the universe came from an eternal stuff that he called the *indefinite.* Anaximenes theorized that air was the basic substance and that it condensed or became less dense to form other materials, such as water or fire.

At about the same time, in what is now southern Italy, Pythagoras explained the universe in terms of numbers. He taught that all things are numbers or, perhaps, could be reduced to numbers. Pythagoras also believed that everything is harmoniously related. On the other hand, Heraclitus saw only strife in the world. He thought that everything constantly changes and moves, and that nothing remains the same.

The teachings of Parmenides, which became influential during the 400's B.C., raised a problem for other pre-Socratics. Until then, philosophers had accepted the existence of change, motion, and *plurality* (reality consisting of many substances). Parmenides held that change, motion, and plurality were unreal because they

require the existence of *what is not.* Parmenides rejected the idea of *what is not* as inconceivable. He said the universe is uniform, immovable, and unchanging, with no generation or destruction.

Parmenides had few followers but great influence. His opponents could not disprove his reasoning, and so they tried to reconcile his conclusions with common sense. Empedocles agreed that there could be no generation or destruction. He explained their apparent existence in terms of four eternal elements—earth, air, fire, and water—mixed by the force of *love* and separated by *strife.* Anaxagoras believed an infinite number of elements had been separated out of an original mixture through the rotation initiated by a force or material he called *Mind.* Each kind of natural substance contains all the elements but in different proportions. Anaxagoras thought matter was infinitely divisible.

In the late 400's B.C., Leucippus and Democritus responded to Parmenides with a theory called *atomism.* They taught that the universe consists of tiny, solid, indivisible bodies called *atoms,* which move about in space and cluster together to form the larger objects of common experience. S. Marc Cohen

Related articles in *World Book* include:

Anaxagoras, Anaximander, Anaximenes, Atomism, Empedocles, Heraclitus, Parmenides, Pythagoras, Socrates, Thales

Press. See **Journalism; Newspaper; Printing; Freedom of the press.**

Pressburg. See **Bratislava.**

Pressure is often defined as force per unit area. In physics, the term is usually applied to *fluids* (gases or liquids). If a fluid is exposed to suitable forces, pressure is produced in it. The greater the force, the greater the pressure. Pressure is measured in pounds per square inch in the inch-pound system customarily used in the United States. It is measured in kilograms per square centimeter or pascals in the metric system.

Atmospheric pressure is produced by the weight of the air from the top of the atmosphere as it presses down upon the layers of air below it. At sea level, the average atmospheric pressure is 14.7 pounds per square inch (101.3 kilopascals). This decreases with altitude because of less air pressing from above.

If a fluid is at rest, pressure is transmitted equally to all its parts and, at any one point, is the same in all directions. The fluid acts this way because the molecules in it move freely. The molecules are far apart in a gas and comparatively close together in a liquid.

The French scientist Blaise Pascal discovered the fact that pressure in a fluid is transmitted equally to all distances and in all directions. He formulated *Pascal's law* to describe the effects of pressure within a liquid (see **Pascal's law**). This law has many practical applications.

The greater the pressure in a gas, the smaller its volume. This decrease in volume occurs because the molecules are pushed closer together. Under ordinary conditions, the volume of a gas decreases by half when the pressure doubles. The law that describes how the volume of a gas changes when the pressure changes is called *Boyle's law,* after Robert Boyle, the Irish scientist who first developed it. The volume of liquids and solids also decreases when pressure increases, but by very much smaller amounts than for gases.

The ability of a gas to compress and expand has many practical uses. For example, air tires, air cushions, and air brakes are based on this elasticity of air.

Pressure changes the boiling point of water. The boiling point is that temperature at which the pressure of the steam is equal to the atmospheric pressure. At sea level, the two pressures are equal at 100 °C or 212 °F. As height increases, the pressure decreases, and the boiling point becomes lower. This makes cooking at high altitudes difficult, because cooking depends on the temperature to which the food is heated, not on whether the surrounding water is boiling. See **Boiling point.**

Wind is the movement of air from a point of high pressure to a point of low pressure. Pressure changes precede storms. Barometers detect storms by measuring such changes. Gregory Benford

Related articles in *World Book* include:

Air, Barometer, Bridgman, Percy Williams, Gas, Gauge, Hydraulics, Manometer

Pressure sore. See **Bedsore.**

Prester John (or *Presbyter John*) was a legendary Christian priest and king. He is supposed to have lived in the 1100's. Many travelers of the Middle Ages, including Marco Polo, claimed that he ruled a vast kingdom in central Asia. Later reports, especially by Portuguese explorers, made him the emperor of Ethiopia. Pope Alexander III sent a messenger to look for him in 1177, but the messenger never returned. Stanley K. Stowers

Pretoria, *prih TOHR ee uh* (pop. 525,583), is the administrative capital of South Africa. The executive branch of the government directs the country's administrative affairs from Pretoria. Cape Town is South Africa's legislative capital, and Bloemfontein is the judicial capital. In 2000, Pretoria became part of the newly created City of Tshwane Metropolitan Municipality. Tshwane has a population of about 1,800,000. For Pretoria's location, see **South Africa** (political map).

Many Pretoria residents hold government jobs. Others work in railroad workshops, and in factories that make cement, chemicals, machinery, motor vehicles, and plastics. Pretoria is a leading cultural and research center. It has a number of museums and art galleries, the national zoo, and three universities.

Boers (now called Afrikaners), who are people mainly of Dutch descent, founded Pretoria in 1855. When the Union of South Africa was formed in 1910, Pretoria became the administrative capital. Peter Sullivan

Pretzel is a type of German biscuit. It is brittle and twisted, with a glazed, salted surface. According to tradition, the first pretzels were made in the early 600's by European monks as a reward for children who learned their prayers. The original pretzel's shape represented the crossed arms of a child praying. The first commercial pretzel bakery in the United States opened in Lititz, Pennsylvania, in 1861. Kay Franzen Jamieson

Prevailing westerly is a wind that blows over the north and south middle latitudes from west to east. In the Southern Hemisphere, prevailing westerlies over the ocean blow with such force that sailors call this region the "roaring forties." The winds are not steady because they are often interrupted by cyclonic storms. Over the land masses of the Northern Hemisphere, the westerlies are often turned from their course by moun-

tain ranges. The United States and the southern half of Canada lie within the westerlies' path. Mark A. Cane

Prévert, Jacques (1900-1977), was probably the most popular French poet of the mid-1900's. His popularity resulted almost entirely from one volume, *Paroles (Spoken Words),* which became an immediate best seller when it appeared in 1946. Prévert's poems are rich in the clever use of words and humor. They declare the need for individual happiness and love, and attack with playful mockery the most respected human institutions. The simple sentence structure of many of the poems makes them favorites in beginning French courses.

Prévert was born in Neuilly-sur-Seine. He joined the Surrealist movement during the 1920's, and his poems reflect the fantasy and freedom of expression typical of Surrealism. Prévert also wrote the scripts for several films directed by Marcel Carné. Jean-Pierre Cauvin

Previn, *PREH vuhn,* **André,** *ahn DRAY* (1929-), is an American conductor, pianist, and composer. Previn served as conductor of the Houston Symphony Orchestra from 1967 to 1969. He conducted the London Symphony Orchestra from 1968 to 1979. He was music director of the Pittsburgh Symphony Orchestra from 1976 to 1984. Previn served as the music director of the Royal Philharmonic Orchestra from 1985 to 1988 and the Los Angeles Philharmonic Orchestra from 1985 to 1990.

As a pianist, Previn achieved success playing both classical music and jazz. He composed and arranged music for several films and recordings, and he received four Academy Awards for his film work. Previn has also composed concertos and other classical pieces.

Previn was born in Berlin, Germany. His family settled in the United States in 1939. He became an American citizen in 1943. He described his movie career in *No Minor Chords: My Days in Hollywood* (1991). John H. Baron

Priam, *PRY uhm,* in Greek mythology, was the last king of Troy and ruler of the city during the Trojan War with Greece. He was noted for his kindness, dignity, and respect for the gods. Priam's wife was Hecuba (or Hecube). By her and various other women, Priam had 50 sons and 50 daughters. The most famous were the sons Hector and Paris and the daughter Cassandra.

Most of Priam's sons died in the war. The king went alone at night to the tent of the Greek warrior Achilles to beg for Hector's body so he might give it a proper burial. Achilles pitied the old man and returned the body to him. Later, as Priam clung to the altar of Zeus on the night that Troy fell, Achilles's son Neoptolemus (or Pyrrhus) killed him. Justin M. Glenn

See also **Hecuba; Iliad; Paris** (mythology).

Pribilof Islands, *PRIHB uh LAWF,* are four hilly islands in the Bering Sea. They are the home of the world's largest fur seal herd. Each spring, about 1 $\frac{1}{2}$ million fur seals go to the Pribilofs to breed. The Pribilofs include the large islands of St. Paul and St. George, and the smaller islands of Otter and Walrus. They cover 76 square miles (197 square kilometers) and have about 700 people. The United States obtained the islands when it bought Alaska in 1867. For location, see **Alaska** (physical map).

For many years, there were no restrictions on hunting the seals. As a result, they almost became extinct. In 1911, the United States, Russia, the United Kingdom, and Japan signed a treaty in which they agreed to protect the seals, and the United States received charge of the herd. In 1957, the United States, Canada, the Soviet Union, and Japan agreed to restrict seal hunting to the Pribilofs and two Soviet islands. The treaty expired in 1984. Since then, animal protection laws have prevented commercial hunting of fur seals around the islands.

In 1786, the Russian explorer Gerasim Loginovich Pribylov (also spelled Pribilof) discovered the islands. They were then uninhabited. Russian traders brought Aleuts from the nearby Aleutian Islands to the Pribilofs to help hunt seals. The Aleuts continued to settle there. Today, St. Paul has more than 500 people. It is Alaska's largest Aleut community. Claus-M. Naske

See also **Bering Sea controversy; Seal.**

Price is the amount of money for which something can be bought or sold. The price states the worth in money of a unit of a certain good or service. This article discusses how prices are determined and what prices do in *free market systems.* These systems, in which people carry out their economic activities largely free from government control, operate in the United States and Canada. In *planned economies,* such as those of Communist nations, the government often determines prices.

How price is determined

Demand and supply. Prices are based on the economic forces of *demand* and *supply. Demand* is the quantity of a good or service that consumers are willing and able to buy. *Supply* is the quantity producers and other people are willing and able to offer for sale.

Demand usually varies with a product's price. The lower the price, the greater the demand. This is because people who want the product will buy more of it at a lower price and because the low price will attract new buyers. The tastes and incomes of buyers and potential buyers also determine demand. In addition, demand for one product may be affected by the prices of related products. For example, if an increase in the price of automobiles causes people to buy fewer cars, there will be less demand for automobile tires.

Supply also varies with prices, but in the opposite way from demand. Often, the higher the price, the greater the quantity producers want to supply. But the main determiner of supply is the cost of production, which depends primarily on the costs of labor, materials, and capital. The cost of production may rise or drop as greater quantities are produced, with an associated price change. But this cost and the price may also stay about the same, as greater quantities are produced.

In a free market system, the price of a product tends to settle at an *equilibrium price.* This is a price at which buyers are able to purchase all they want, and at which sellers are able to sell all they wish to sell. As the conditions of supply and demand change, the equilibrium price moves up or down.

Monopoly. The price of a product may be affected by special circumstances. For example, a business firm may gain a *monopoly*—that is, it may control the supply of a product for which there is no close substitute. The firm then may use its *monopoly power,* or *market power,* to raise the product's price. It may raise the price above whatever equilibrium price would have been achieved under competition. Because there are no close substitutes for the product, consumers who want the product will have to pay the high price.

Government intervention in the market, through *price controls* or other means, also affects prices. Various price controls may benefit producers or consumers. A *price ceiling* is a maximum price that is designed to help a certain group of consumers. For example, some city governments put price ceilings on rental units to limit the amount of rent a landlord may charge a tenant. A *price floor* is a minimum price established by a government. This price is designed to aid certain producers. For example, the U.S. government has established price floors, known as *support prices,* for many agricultural products in *price support programs* to help farmers gain profits. The government helps to maintain a support price partly by buying certain quantities of the product and thereby increasing demand.

The government also may use other types of price controls, such as a *price freeze.* This method holds prices at a certain level, such as the level they were at when the price freeze went into effect.

Although interventions help solve some problems, they may cause others. For example, an effective support price is set above the equilibrium price and a *surplus* of the product will result. Low prices caused by price ceilings may cause shortages by increasing demand for a product or by decreasing supply.

What prices do

In a free market system, an equilibrium price *clears the market*—that is, it satisfies buyers and sellers. Price systems thus ration products, distributing them to people willing and able to pay for them.

Prices help determine what goods and services should be produced, how they should be produced, and for whom they should be produced. Consumers let producers know what to produce by indicating the prices they are willing to pay for particular goods and services. Producers decide how to produce goods and services based on the prices of materials and labor. How much people can afford to buy determines for whom goods are produced. Irving Morrissett

Related articles in *World Book* include:

Capitalism
Discount
Economics
Inflation
Marketing (Pricing)
Monopoly and competition
Price control
Supply and demand
Value

Price, Hugh Bernard (1941-), became president of the National Urban League in 1994. Before taking the post, he had served since 1988 as a vice president of the Rockefeller Foundation, a charitable organization.

Price was born in Washington, D.C. He graduated from Amherst College in 1963 and Yale Law School in 1966. He then worked until 1968 as a lawyer with the New Haven Legal Assistance Association in New Haven, Connecticut. The association provided free legal service to poor people. From 1968 to 1970, Price headed a political group called the Black Coalition of New Haven. From 1970 to 1975, he was a partner in an urban affairs consulting firm in New Haven. Price then worked as human resources administrator for the city in 1977 and 1978.

In 1978, Price joined the editorial board of *The New York Times.* As a member of the board until 1982, he wrote editorials on such issues as criminal justice, education, and welfare. From 1982 to 1988, Price was a senior vice president of WNET-TV, a public television station in New York City. Hanes Walton, Jr.

See also **Urban League.**

Price, Leontyne, *LEE uhn TEEN* (1927-), an African American singer, ranks among the most celebrated sopranos of her time. Her brilliant voice has an exciting vibrating quality and an unusually wide range. Price has gained acclaim both for her concert recitals and for her opera performances. The title role in the opera *Aida* is perhaps her most famous operatic part. Her performance in the role in 1960 at La Scala in Milan, Italy, made her internationally famous. She was the first black woman to sing a leading role with that famous opera company.

Price was born in Laurel, Mississippi. She made her first appearance at the Metropolitan Opera in New York City in 1961 in *Il Trovatore.* She received the Presidential Medal of Freedom in 1964 and the Spingarn Medal in 1965. Price retired as an opera performer in 1985, but she has continued to sing recitals. Charles H. Webb

Price control is a method used by a government to influence prices for the benefit of producers or consumers. Price controls are often used to prevent prices from rising too rapidly. A government may use price controls in several ways. It may establish the maximum price that can be charged for certain goods or services. It may freeze prices where they were when the controls became effective. Or a government may establish a minimum price that can be charged.

Governments may use price controls to fight *inflation,* a decrease in the purchasing power of money (see **Inflation**). Inflation benefits some people at the expense of others, and so it can disrupt production and cause social disorder. For example, workers may strike for higher pay if the cost of living rises faster than wages.

Price controls have been used chiefly during wartime, when heavy government spending makes inflation most dangerous. The United States and Canada imposed price controls during World War II (1939-1945). The United States used price controls less successfully during the Korean War in the early 1950's. The success of price controls depends primarily on how vigorously the government enforces the price controls and on public cooperation. Irving Morrissett

See also **Rationing; World War II** (On the home front).

Prickly-ash is the name of a large group of trees or shrubs found mainly in tropical regions. Prickly-ashes are not true ash trees. The name refers to the leaves, which resemble those of true ashes (see **Ash**). Prickly-ashes have sharp spines on the twigs and fragrant bark.

Several species of prickly-ashes grow in the United States. The *southern prickly-ash,* also known as *Hercules club,* is a small tree with a warty trunk. It grows in sandy soil from Virginia to eastern Texas. It is also called the *toothache tree* because the bark produces a cooling and numbing sensation when chewed and has been used as a painkiller for toothache. The *northern prickly-ash,* also called *common prickly-ash,* grows in dry, rocky woods or lowland areas, mainly in the eastern and central United States. It contains an oil used in some medicines.

Scientific classification. Prickly-ashes belong to the family Rutaceae. The scientific name for the southern prickly-ash is *Zanthoxylum clavaherculis.* The northern prickly-ash is *Z. americanum.* Michael J. Baranski

Prickly heat is a skin rash of tiny, red pimples that itch. It is also called *heat rash.* It may appear often when the weather is warm and moist. The rash occurs when sweat pores are blocked so that sweat cannot reach the surface of the skin. Prickly heat is common among infants. It is relieved by keeping the skin cool with cool compresses and mild dusting powders. The disorder is annoying but not harmful. Yelva Liptzin Lynfield

Prickly pear, also called *nopal* or *Indian fig,* is a type of cactus with prickly fruits that are shaped somewhat like a pear or fig. Many species of prickly pears grow in dry parts of the southwestern United States and northern Mexico. They can stand long periods with little water, but they grow better with moderate rainfall, as in parts of Florida, southern Brazil, and northern Argentina.

The stem of the prickly pear consists of a series of flat, leaflike segments called *joints.* The flowers and fruit grow on the edges of the joints. In Mexico and Central America, the edible kinds are called *tuna.* The fruits are common in markets throughout Latin America. Luther Burbank developed spineless varieties, which are raised as food for people and livestock.

Prickly pears have been introduced into Mediterranean countries, India, Sri Lanka, South Africa, the Canary Islands, and Madagascar. The chief reason for their widespread cultivation is their food value and, formerly, their use in the cochineal dye industry. The cochineal insect, which gives a red dye, feeds on prickly pears.

One species of prickly pear was brought to Australia in 1788 for a cochineal dye industry that was never established. Later, two other species were brought there as curiosities. From 1900 to 1925, they spread so quickly that they made about 30 million acres (12 million hectares) useless for crops or grazing. The Australian government then brought in an Argentine moth, *Cactoblastis cactorum.* Its larvae live in the joints and destroy them. Within seven years, the heavy growth of prickly pears had been almost destroyed. Philip W. Rundel

Scientific classification. Prickly pears belong to the cactus family, Cactaceae. They are members of the flat-stemmed group of genus *Opuntia.*

See also **Flower** (picture: Flowers of prairies and dry plains); **Cactus** (picture).

Priest, in many religions, is the title of certain members of the clergy. A priest primarily performs religious ceremonies and gives religious advice.

Religions that have a priesthood include Buddhism, Hinduism, Shinto, and Taoism. In Christianity, the Anglican, Eastern Orthodox, Mormon, Roman Catholic, and Scandinavian Lutheran denominations use the term *priest.* Many of these priests serve as pastors of local churches. In ancient times, Judaism had a class of priests, led by a high priest (see **High priest**). Today, however, Judaism has no priesthood.

Many religions teach that priests have special authority to transmit sacred power to others through ceremonies. In Hinduism, only *Brahmans* (priests and scholars) may perform ceremonies involving reciting lines from scriptures known as the Vedas. Hinduism teaches that these scriptures have special powers.

Some religions limit the priesthood to certain families or classes. In other religions, dreams or other signs are used to choose priests. Many religions exclude women from the priesthood. In most cases, a person must study to enter the priesthood. Robert S. Ellwood, Jr.

See also **Bishop; Celibacy; Minister.**

Priestley, John Boynton (1894-1984), was a British novelist, playwright, and journalist who wrote novels in the realistic tradition of the 1800's. His best-known novel is *The Good Companions* (1929), an amusing story of a wandering music-hall troupe. His nostalgic novel *Lost Empires* (1965) also concerns the music-hall world. *Angel Pavement* (1930) is a more serious novel about London's business world. Priestley wrote much nonfiction, including *Literature and Western Man* (1960). His most popular plays include *Dangerous Corner* (1932) and *An Inspector Calls* (1945), satires on middle-class life. *Time and the Conways* (1937) is a science-fiction play.

Priestley was born Sept. 13, 1894, in Bradford, Yorkshire. After graduating from Cambridge University, he became a journalist in London in 1922. Sharon Bassett

Priestley, Joseph (1733-1804), a British clergyman and chemist, shares the credit for the discovery of oxygen with Carl Wilhelm Scheele of Sweden (see **Oxygen**). Priestley called the gas "dephlogisticated air." French chemist Antoine Lavoisier named it *oxygen.*

Priestley was born near Leeds, England, on March 13, 1733. He studied for the ministry. After preaching in Suffolk and Cheshire, he taught at the *dissenting* (nonconformist) academy in Warrington. Ordained in 1762, he became a dissenting minister in Leeds and Birmingham.

At Warrington, with the aid of Benjamin Franklin and others, Priestley wrote his first scientific work, describing his experiments with electricity. Priestley turned to chemistry in the late 1760's. He discovered oxygen in 1774 and published an account of his discovery in 1775. Priestley also isolated and identified nitrous oxide (laughing gas) and sulfur dioxide.

Priestley's sympathies for the cause of the French Revolution made him unpopular in England. In 1791, an angry mob burned his home and chapel in Birmingham. Priestley left England and moved to the United States in 1794. He settled permanently in Northumberland, Pennsylvania. Seymour Harold Mauskopf

Primakov, *pree muh KAWF,* **Yevgeny Maksimovich,** *yehv GEH nee mak SIHM uh vihch* (1929-), was prime minister of Russia from 1998 to 1999. He had served as minister of foreign affairs from 1996 to 1998.

Primakov was born Yona Finkelstein in Kiev, Ukraine, then part of the Soviet Union, on Oct. 29, 1929. He spent his childhood in Tbilisi, Georgia, also a part of the Soviet Union at that time. He changed his name as a youth. He graduated from the Moscow Institute of Oriental Studies in 1953 and received a doctorate in economics from Moscow State University in 1956.

Primakov joined the Communist Party in 1959. From 1962 to 1970, he worked for the Communist newspaper *Pravda.* He served as the Middle East correspondent and became fluent in Arabic. In the 1970's and 1980's, he held administrative posts with the Soviet Academy of Sciences and advised Soviet leaders on foreign policy.

In 1991, Primakov became head of the foreign intelligence branch of the KGB, the Soviet intelligence agency. After the Soviet Union dissolved in December of that year, he became head of Russia's Foreign Intelligence Service. He held that post until 1996. Donald J. Raleigh

Primary color. See **Color** (Methods of color production).

Primary election is a method of selecting candidates to run for public office. In a primary election, a political party, in effect, holds an election among its own members to select the party members who will represent it in the coming general election. Any number of party members can run for an office in a primary. But only the winning candidate can represent the party in the general election. Parties learn from the primary votes which candidates the members of their parties prefer. When several candidates enter a primary, the winner may receive less than 50 percent of the vote. Some states, especially in the South, then hold a *run-off primary*, in which the two candidates with the highest number of votes run against each other.

Direct and indirect. The *direct primary* is the most common form of primary election. In the direct primary, party members who want to run for office file petitions to have their names placed on the ballot. Voters then vote directly for the candidates of their choice. In an *indirect primary*, party members vote for delegates to party conventions, where candidates are chosen.

Open and closed. A primary election is considered *closed* when each voter must declare a choice of party, either when registering to vote or when voting. Party members can vote only for candidates on their party's ballot, and their party's contest is closed to members of other parties. In an *open primary*, the voter receives ballots for all the parties in the election, and chooses both party and candidates in the voting booth. A few states hold a primary called a *blanket primary*, in which voters may choose candidates from different parties.

Nonpartisan primaries are often used for judicial, school board, and local elections. Candidates are listed on the ballot with no indication of political affiliation. The voters choose candidates on the basis of their individual merits, not their party membership. The candidates with the greatest numbers of votes become the opposing candidates in the general election.

The presidential primary is used in over half of the states to choose delegates to the national party conventions. Each candidate who enters the election lists a slate of delegates who have promised to support the candidate at the convention. The party members show their choice for the presidential nomination by voting for the slate of delegates committed to that candidate. Primaries that select about two-thirds of the delegates are held in the first six months of presidential election years.

History. Before primary elections were used, political parties nominated candidates for office at party conventions and caucuses. Political bosses often hand-picked candidates, making shady deals to win enough votes. People gradually turned against this system as being undemocratic and open to corruption. Reform movements urged "No More Boss Rule" and "Down with King Caucus!"

In 1903, Wisconsin passed the first statewide primary law. Within 10 years, most states did likewise. Today, every state uses some form of primary election for statewide offices. Several states still use caucuses to nominate presidential candidates. Robert Agranoff

See also **Caucus; Election.**

Primary school. See **Elementary school.**

Primate is a member of the group of mammals made up of human beings and the animals that most closely resemble them. Scientists classify about 230 living *species* (kinds) of mammals as primates. These diverse animals range in size from 1 ounce (28 grams) to almost 400 pounds (181 kilograms). Most primates belong to one of two major groups, commonly known as *prosimians* and *anthropoids*. Prosimians include lemurs and generally have a smaller body size than other primates. Anthropoids consist of monkeys, apes, and human beings. One small group of primates, the *tarsiers*, have characteristics of both prosimians and anthropoids. But scientists consider them more closely related to anthropoids. Biologists classify anthropoids and tarsiers in a group called the *Haplorhini*, and prosimians in a group called the *Strepsirhini*.



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Primates are social animals that commonly live in trees. The tarsiers pictured here inhabit forests of Southeast Asia. They are active at night and have huge eyes for excellent night vision.

Primates share certain traits in common. The first primates evolved as tree-living animals. Thus they developed grasping hands that enabled them to hang onto branches and move easily from branch to branch. Most primates also have grasping feet, and some even have grasping tails. Primate eyes face forward, providing excellent vision. Most species rely on sight more than they do hearing or smell.

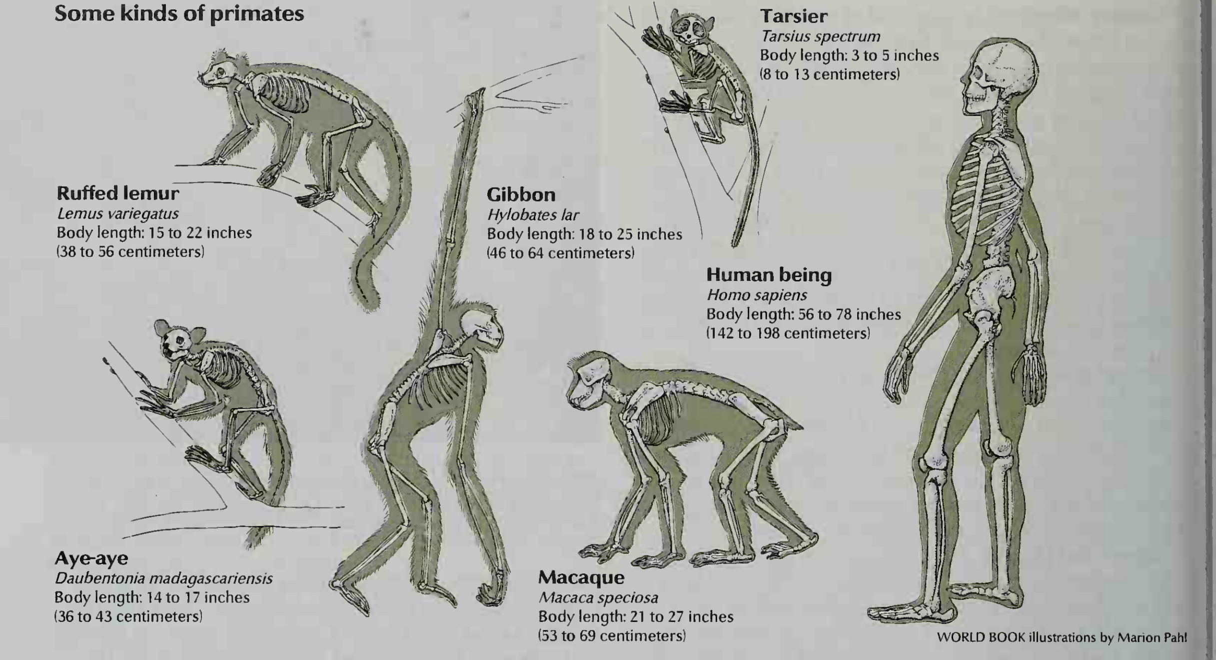
In general, primates have large brains and rank among the most intelligent and social of animals. Many species live in large, complex social groups. Most primate young take a long time to mature, so they rely heavily on their mother. The young learn much from her, including what to eat and what things to avoid.

Most scientists believe that the earliest primates evolved around 65 million years ago. Nonhuman primates once occupied more of North America, Europe, and Asia than they do today. At present, almost all nonhuman primates inhabit tropical climates in Africa, Asia, and South America. Many of them have become threatened with extinction.

Kinds of primates

Prosimians are the more primitive of the two groups of primates. Most prosimians, including lemurs, live on the island of Madagascar off the southeast coast of Africa. Other prosimians inhabit Asia and continental Africa. These include galagos, lorises, and pottos.

Some kinds of primates



WORLD BOOK illustrations by Marion Pahl

Lemurs are the most diverse group of prosimians. The smallest lemur, the pygmy mouse lemur, weighs about 1 ounce (28 grams). The largest lemur, the indri, weighs about 20 pounds (9 kilograms). Lemurs have projecting front teeth that form a "tooth comb," which they use to groom themselves and each other. They also use a claw on the second toe of each foot for grooming. Many lemurs have long lower limbs and short upper limbs, enabling them to leap gracefully from branch to branch.

Lemurs live in social groups that often vary from 10 to 20 individuals. Some species are *diurnal* (active during the day), while others are *nocturnal* (active at night).

Aye-ayes rank among the rarest of all primates. These nocturnal lemurs grow to about 7 pounds (3 kilograms) in weight. They search for insects, an important food, using some remarkable body features. First, they gnaw through tree bark with their incisors, which grow continuously. Then they use a long claw on the third finger of each hand to probe for insects within the tree. Unlike other lemurs, aye-ayes live alone.

Galagos and lorises are two closely related types of nocturnal prosimians. Both live in Africa, but lorises also inhabit India and Southeast Asia. Like the lemurs, galagos and lorises have "tooth combs" and a grooming claw on the second toe. Galagos have remarkable leaping ability. Though these primates measure only 4 to 18 inches (10 to 46 centimeters) long, some can jump over $6\frac{1}{2}$ feet (2 meters). Lorises, however, move slowly in the trees.

Tarsiers are small, nocturnal primates of Southeast Asia. They resemble prosimians in some respects and anthropoids in others. Scientists once thought tarsiers were closer to prosimians in their evolutionary history and anatomy. But now many biologists classify them closer to the anthropoids. The tarsiers' nocturnal lifestyle resembles that of many prosimians. Tarsiers have huge eyes for excellent night vision. Each of these eyes is bigger than their brain. Tarsier skulls, however, resemble those of anthropoids more than those of prosimians. Tarsiers also have big hands and feet. Their hands help them to catch prey, while their feet enable them to execute dramatic leaps in the forest.

Anthropoids constitute a much larger and more diverse group than do prosimians. They consist of six scientific families. Two families of *New World monkeys* range from Mexico through South America. Three other families—the *Old World monkeys,* the *lesser apes,* and the *great apes*—inhabit Africa, Europe, and Asia. Human beings live throughout the world.

The bodies of anthropoids differ from those of prosimians. In monkeys, apes, and human beings, the two sides of the lower jawbone are fused together. These sides remain unfused in prosimians. Anthropoid and prosimian skeletons also differ. Most monkeys and apes have longer, better developed upper limbs than do prosimians, enabling them to walk on all four limbs and swing from the branches of trees. Unique among anthropoids, human beings possess long lower limbs and relatively short upper limbs for walking full-time on two legs. While prosimians have a well-developed sense of smell, anthropoids rely more on sight, and most of them have color vision. With the exception of the owl monkey of South America, anthropoids sleep at night and remain active during the day.

New World monkeys inhabit the forests from southern Mexico to northern Argentina. They have evolved separately from other monkeys for about 20 million years.

New World monkeys possess certain body features that distinguish them from Old World monkeys. For example, the nostrils of New World monkeys generally lie farther apart than those of their Old World cousins. Some New World monkeys, such as the howler monkeys, have a *prehensile tail* that can "grasp" branches as a hand does, enabling the animals to hang by their tail.

Prehensile tails have well-developed muscles and sensitive fingerprint skin at the tip. New World monkeys generally possess smaller, less useful thumbs than do Old World monkeys. Some species, including certain spider monkeys, have lost their thumbs completely.

Two unusual types of New World monkeys, the marmosets and tamarins of South America, rank among the smallest primates. Marmosets weigh from 10 to 12 ounces (300 to 350 grams), and tamarins weigh from 12 to 27 ounces (360 to 790 grams). They differ from other New World monkeys in that they have only two molars on each side of their upper and lower jaws. All other anthropoid primates have three. For this reason, scientists classify marmosets and tamarins in a separate family.

All New World monkeys live in trees, but different species occupy different layers of the forest canopy. New World monkeys live in a variety of social groupings. A number of them, including the woolly monkey, gather in groups of up to 70 individuals. Marmosets and others live in small communities of 15 or less.

Old World monkeys live in Africa, Asia, and Europe. Most of these primates have a callous pad of skin on their rumps, which enables them to sit and sleep more comfortably in trees. They also tend to grow larger on average than New World monkeys, and numerous species spend at least part of their time on the ground.

Old World monkeys consist of two groups: the *colobines* and the *cercopithecines.* Colobines include the langurs of Asia and the colobus monkeys of Africa. Colobines eat primarily leaves, which they digest with their large multichambered stomachs. But like all primates, leaf-eaters also consume other types of food. Colobines have longer legs, shorter thumbs, and longer tails than do cercopithecines.

Cercopithecines include the macaques, which live in Asia, Africa, and Europe; and the baboons, mangabeys, and guenons of Africa. Cercopithecines have simpler stomachs. They also have cheek pouches that they can stuff with food for temporary storage.

Old World monkeys inhabit a diverse range of climates, including deserts, tropical rain forests, and colder mountainous regions. The Japanese macaque of Japan lives farther north than any other nonhuman primate. A number of Old World monkeys form complex social groups. Baboons, for example, gather in groups of up to 90 individuals. This larger gathering consists of several smaller groups of about five females and a dominant adult male. Baboons spend more of their lives on the ground than any other monkey.

Lesser apes include the gibbons and the siamang of Southeast Asia. These primates, along with great apes and human beings, have no tail. Gibbons and siamangs also have extremely long upper limbs. Their long arms enable them to hang acrobatically under branches and swing from branch to branch. They also walk *bipedally* (on two legs) high in the trees. Biologists call gibbons and siamangs "lesser apes" because they grow about the same size as many monkeys. Lesser apes also have sitting pads on their rumps, as have Old World monkeys. Gibbons and siamangs mate for life in the wild. They eat mostly fruits and leaves.

Great apes include the orangutan of Southeast Asia and the bonobo, chimpanzee, and gorilla of Africa. Great apes have no tail and, unlike lesser apes, they lack sitting pads on their rumps. Thus they need to build nests in the trees or on the ground for sleeping. Great apes are more closely related to human beings than any other type of primate.

The orangutan ranks as the largest *arboreal* (tree-dwelling) animal. Males weigh on average 180 pounds (80 kilograms), while females average 81 pounds (37 kilograms). Orangutans inhabit rain forests on the Southeast Asian islands of Borneo and Sumatra. Because of their arboreal existence, orangutans have developed huge hands and feet with long, curved fingers and toes. They also have long, powerful upper limbs and extremely flexible joints, especially in the shoulders, hips, wrists, and ankles. Orangutans live more solitary lives than do most other primates. Males forage alone for fruit, their main food, and the only social bonds occur between females and their offspring. Adult males and females interact only to mate.

Gorillas grow larger than any other primate. Some wild male gorillas weigh as much as 390 pounds (177 kilograms). Females weigh about half as much as males. The three subspecies of gorilla—the *mountain gorilla,* the *eastern lowland gorilla,* and the *western lowland gorilla*—all live in central Africa. Gorillas spend most of their time on the ground and eat largely plant foods. They usually live in small groups. Most social interaction occurs between females and their young or between adult males and adult females.

Chimpanzees are the most widely distributed of all the great apes. They range from dry woodlands in western and eastern Africa to humid rain forests in the Congo Basin of central Africa. Chimpanzees spend part of their day in the trees and part on the ground. They eat primarily fruit, but they also consume leaves and insects and even hunt for monkeys and other mammals. Males usually do the hunting in small groups and try to keep the meat for themselves. Other chimpanzees gather around the hunters and get some of the meat by begging or stealing. In chimpanzee societies, males and females form separate groups at times and live together at other times. Chimpanzee behavior also includes activities that scientists once thought only human beings performed, including using tools and engaging in warfare with others of their own kind.

Bonobos, also called pygmy chimpanzees, live south of the Congo River in Congo (Kinshasa). Bonobos closely resemble chimpanzees but differ from them in many ways. Bonobo social groups consist of small bands of males, females, and young. When fruit becomes abundant, several groups may form temporary communities of up to 75 individuals. Bonobos exhibit a much lower level of aggression within their groups than do chimpanzees. Bonobos also spend more time in the trees than their close relatives. Bonobos and chimpanzees share more characteristics with human beings than any other animal does.

Human beings rank as the most widespread of all primates. They are the only primates that permanently walk *bipedally* (on two legs). They also have the most highly developed brain, and they live in the most complex societies. These societies have developed sophisticated *cultures* (ways of behaving and thinking). However, the rapid growth of human populations represents a major threat to the survival of all other primates.

The evolution of primates

Primates have a long evolutionary history that spans roughly the last 65 million years. The first known primate, called *Purgatorius,* probably developed in what is now North America during the end of the Cretaceous Period and the beginning of the Paleocene Epoch. Scientists know little about *Purgatorius* because only a few fossil jaws and teeth have been found. From the middle to late Paleocene, slightly more evolved primates called *plesiadapiforms* appeared. This diverse group of small mammals resembled rodents or shrews. They inhabited North America and Europe.

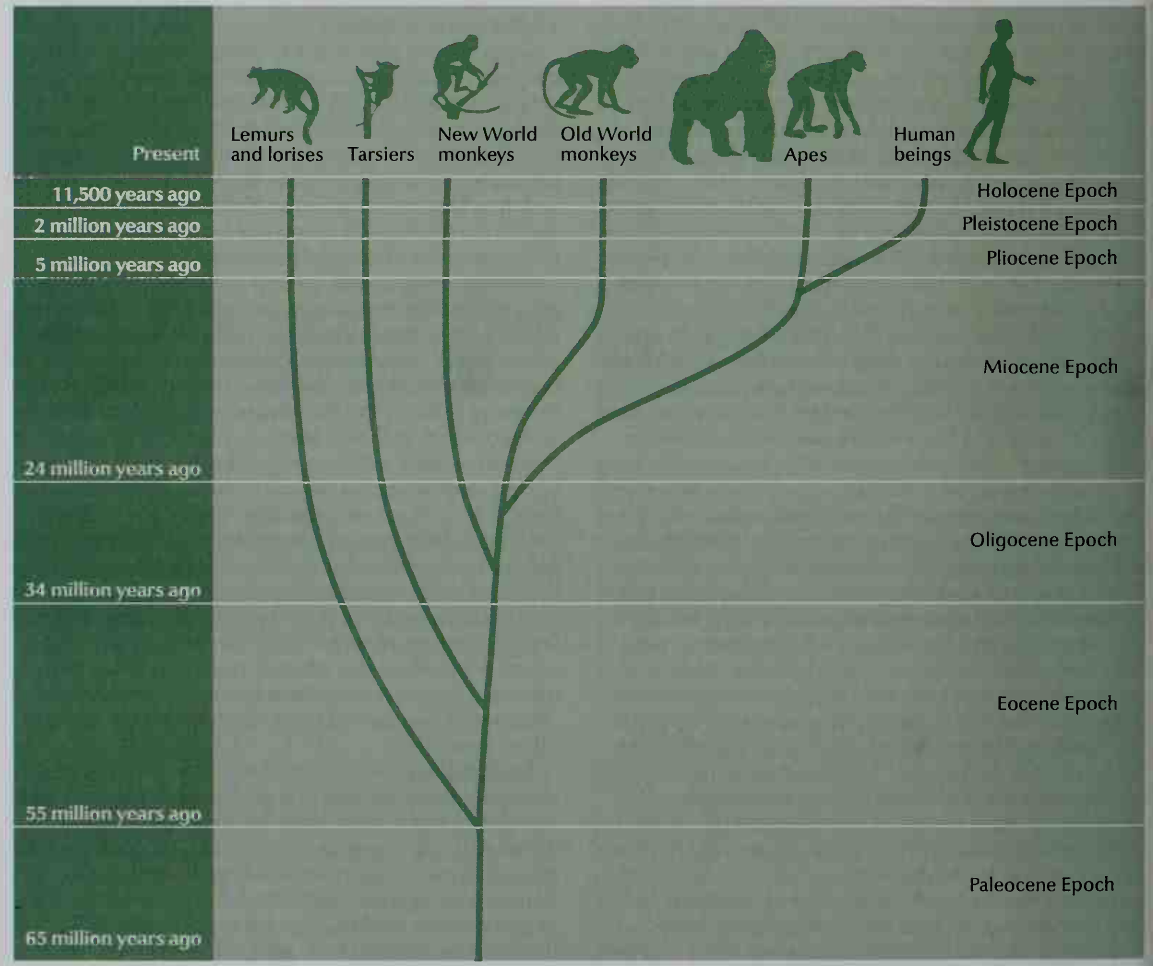
Modern primates evolved in the first part of the Eocene Epoch, approximately 56 million years ago. Two groups, the *adapids* and the *omomyids,* emerged at this time, becoming more abundant than earlier primates. Some scientists believe that adapids evolved into the first monkeys and apes. Other scientists consider the omomyids to be the true ancestors of monkeys and apes.

According to fossil evidence, both the adapids and omomyids more closely resembled living primates than did plesiadapiforms. They had larger brains, shorter faces, and a bony ring encircling each eye. Adapids and omomyids relied more on sight and less on smell than did earlier primates. They also developed hands and feet that could more easily grasp tree branches and other objects.

During the end of the Eocene Epoch and the beginning of the Oligocene Epoch—from about 40 million years ago to about 34 million years ago—the first true monkeys appeared in the Eastern Hemisphere. Scientists have discovered a few fossil primates in Southeast Asia from the Eocene Epoch, including *Amphipithecus, Eosimias,* and *Pondaungia.* These primates may represent the oldest anthropoids. But many scientists still believe animals called *parapithecids,* from the Oligocene Epoch in what is now Egypt, were the first true anthropoids. Another group of Oligocene primates from Egypt, the *propliopithecids,* probably represent the first true apes.

Primate family tree The earliest known primates probably appeared about 65 million years ago, at the end of the Cretaceous Period and the beginning of the Paleocene Epoch. True monkeys and apes had evolved by the Oligocene Epoch. The earliest known members of the *hominid* family, to which human beings belong, may have developed during the late Miocene Epoch and the early Pliocene Epoch.

WORLD BOOK illustration



The earliest known members of the *hominid* family, to which human beings belong, may have developed about 5 million years ago, at the beginning of the Pliocene Epoch. Modern human beings evolved during the Pleistocene Epoch, which lasted from 2 million to 11,500 years ago.

People and nonhuman primates

The study of modern primates. *Primatologists,* the scientists who study nonhuman primates, have learned much about our closest relatives. Studies of great apes have revealed much about the evolution of our own species. Such studies have also disproved much of what we once believed about these animals. The work of the British primatologist Jane Goodall, for example, showed that chimpanzees use tools and engage in tribal warfare against other chimpanzees. Scientists once believed only people displayed such behaviors.

Some important primate research takes place in laboratories. For example, laboratory studies of the genetic makeup of chimpanzees have revealed how closely these primates are related to human beings. Other scientists are working to produce *clones,* or genetic copies, of monkeys. Such clones may prove useful in medical research.

Conservation. Today, nonhuman primates survive mostly in remote tropical areas that have little contact with human beings. Some of the most remote areas inhabited by primates remain unknown to modern science. Since 1990, in fact, scientists have discovered and described dozens of new primates in Madagascar, continental Africa, Southeast Asia, and Brazil.

But even while primatologists identify new species in the wild, the survival of many more primate species has become threatened. The chief threat to their survival is habitat destruction. Economic pressures in developing countries often drive people to cut down the rain forests for wood and for agriculture. Other human activities also endanger primates. Some of the most disturbing ways human beings threaten primate survival include the illegal trade in pets, the use of primate tissues in traditional medicine, and even the hunting of primates for food.

Some of the most endangered primates include our closest relatives, the great apes. The International Union for the Conservation of Nature and Natural Resources (IUCN) lists all the great apes as threatened or endangered. The mountain gorilla ranks as the most highly endangered, with only a few hundred individuals left in the Virunga Mountains of East Africa. In addition to habitat destruction and hunting, persistent political and economic instability in Africa and Asia further threaten the survival of our closest relatives. To continue learning about ourselves and our relationships to the natural world, human beings must take responsibility for preserving primates and their habitats. Randall L. Susman

Scientific classification. Primates make up the order Primates in the class Mammalia and the phylum Chordata.

Related articles in *World Book.* See the separate articles on each primate mentioned in this article. See also **Ape; Fossey, Dian; Goodall, Jane; Prehistoric people.**

Prime meridian. See Greenwich Meridian.

Prime minister heads the executive branch of government in countries with a parliamentary system. This leader is called a *chancellor* or *premier* in some countries. In most parliamentary systems, the prime minister leads the government in the formation of domestic and foreign policy and is the voice of the nation in international affairs. Canada, the United Kingdom, France, and many other countries have a prime minister. In France, however, a president manages foreign affairs.

The prime minister is officially appointed by the *head of state,* who is typically a monarch, governor general, or president. In most systems, the head of state has little choice of whom to appoint. The prime minister is normally the leader of the *majority party,* the party that holds most of the seats in the legislature. If no single party wins a majority of seats, two or more parties form a *coalition,* a grouping of parties that holds most of the seats in parliament. The leader of the coalition's chief party then becomes prime minister.

The prime minister names a *cabinet,* which consists of department heads called *ministers.* The ministers are responsible for making government policy. The membership of a coalition cabinet reflects the relative strengths of the parties in the coalition. In most systems, the ministers are members of parliament. Some systems require the prime minister to gain parliament's approval of the cabinet or its program.

The prime minister and the cabinet are responsible to the legislature and must resign if they lose a *vote of confidence.* In such a vote, the legislature decides whether to support a matter of importance to the prime minister's program. At any time, the prime minister may dissolve parliament—or have the head of state do so—and call new elections. Many parliamentary systems require a general election if one has not been held for a certain number of years.

Some political divisions within countries also have prime ministers. Canadian provinces, for example, have prime ministers called premiers. Gerald Benjamin

Related articles in *World Book* include:

Cabinet
Government (The organization of government)
Parliament
President (Dual presidency)
Prime minister of Canada
United Kingdom (table: British prime ministers)

Prime minister of Canada is the leader of the Canadian national government. Queen Elizabeth II of the United Kingdom, who is also queen of Canada, is Canada's official head of state. The queen, on the recommendation of the prime minister, appoints the *governor general* as her representative in Canada. But the prime minister actually directs the government of Canada.

Canada has a parliamentary system of government. Under this system, the political makeup of the House of Commons, the lower house of Parliament, determines who serves as prime minister. The office traditionally goes to the leader of the party who can command a majority in the House. Almost every prime minister has been a member of the House. The exceptions were Sir John J. C. Abbott, who served in 1891 and 1892, and Sir Mackenzie Bowell, who served from 1894 to 1896. Both were members of the Canadian Senate.

The prime minister has three main duties. These duties are (1) to lead the governing party in Parliament, (2) to develop Canada's domestic and foreign policies, and (3) to direct, with the aid of the Cabinet, the government. The office of prime minister has no fixed term. However,

Portrait gallery of the prime ministers

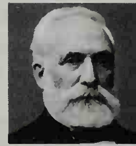

1. Sir John A. Macdonald


2. Alexander Mackenzie


3. Sir John A. Macdonald


4. Sir John J. C. Abbott


5. Sir John S. D. Thompson


6. Sir Mackenzie Bowell


7. Sir Charles Tupper


8. Sir Wilfrid Laurier

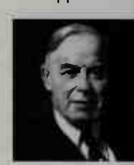

9. Sir Robert L. Borden


10. Sir Robert L. Borden


11. Arthur Meighen


12. W. L. Mackenzie King


13. Arthur Meighen


14. W. L. Mackenzie King


15. Richard B. Bennett


16. W. L. Mackenzie King


17. Louis S. St. Laurent


18. John G. Diefenbaker


19. Lester B. Pearson


20. Pierre Elliott Trudeau


21. Joe Clark


22. Pierre Elliott Trudeau


23. John N. Turner


24. Brian Mulroney


25. Kim Campbell


26. Jean Chrétien

general elections are held at least every five years.

How the prime minister is chosen. Every party leader in Canada could someday become the prime minister. Party leaders are ordinarily chosen in conventions that resemble those held in the United States to nominate candidates for president and vice president.

A general election may be called for a variety of reasons. The prime minister must have the support of a majority of the House to remain in office. If the House passes a *vote of no confidence* in the prime minister's administration, the prime minister must then either resign or request that the governor general call a general election. The prime minister also may voluntarily request that an election be held in the hope of increasing the number of seats held by his or her party in the House or to test an issue.

The prime minister determines the date of a general election, and the election campaign lasts about eight weeks. If the party led by the prime minister again wins a majority in the House, he or she remains in office. If the party loses control of the House, the prime minister resigns. The leader of the largest party is offered the prime ministership by the governor general and is sworn into office. If a prime minister dies in office, the governor general appoints a successor, always on the advice of senior party figures.

Roles of the prime minister. The office and duties of the prime minister are not described in Canada's constitution but are based on those of the British prime minister. As the leader of the House of Commons, the prime

The prime ministers of Canada

	Served	Political party
Sir John A. Macdonald	1867-1873	Conservative
Alexander Mackenzie	1873-1878	Liberal
Sir John A. Macdonald	1878-1891	Conservative
Sir John J. C. Abbott	1891-1892	Conservative
Sir John S. D. Thompson	1892-1894	Conservative
Sir Mackenzie Bowell	1894-1896	Conservative
Sir Charles Tupper	1896	Conservative
Sir Wilfrid Laurier	1896-1911	Liberal
Sir Robert L. Borden	1911-1917	Conservative
Sir Robert L. Borden	1917-1920	Unionist
Arthur Meighen	1920-1921	Unionist
W. L. Mackenzie King	1921-1926	Liberal
Arthur Meighen	1926	Conservative
W. L. Mackenzie King	1926-1930	Liberal
Richard B. Bennett	1930-1935	Conservative
W. L. Mackenzie King	1935-1948	Liberal
Louis S. St. Laurent	1948-1957	Liberal
John G. Diefenbaker	1957-1963	Progressive Conservative
Lester B. Pearson	1963-1968	Liberal
Pierre Elliott Trudeau	1968-1979	Liberal
Joe Clark	1979-1980	Progressive Conservative
Pierre Elliott Trudeau	1980-1984	Liberal
John N. Turner	1984	Liberal
Brian Mulroney	1984-1993	Progressive Conservative
Kim Campbell	1993	Progressive Conservative
Jean Chrétien	1993-	Liberal

Each prime minister has a separate biography in *World Book*.

Facts in brief about the prime minister

Qualifications: The leader of any political party may become prime minister. Party leaders are chosen in political conventions and are usually members of the House of Commons. Candidates must be Canadian citizens.

How elected: The office of prime minister is normally assigned to the leader of the political party that has the most seats in the House of Commons. Seats in the House of Commons are determined by general elections. Election campaigns last about eight weeks.

Swearing in: The governor general formally appoints the prime minister and the prime minister's cabinet members at a swearing-in ceremony.

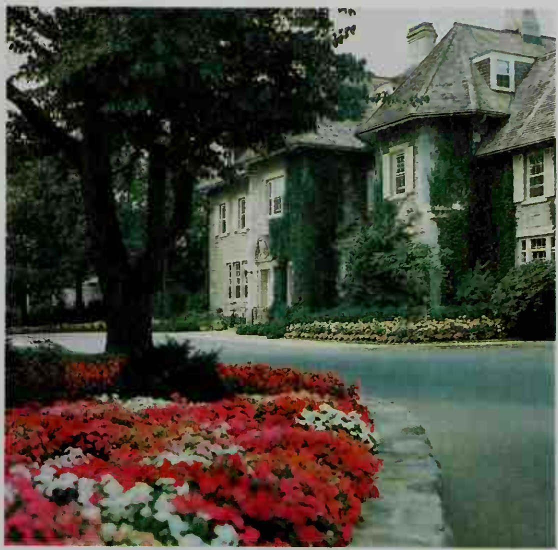
Term: The office of prime minister has no fixed term. General elections may be called for a variety of reasons. Elections are held at least every five years. Party leaders may serve as prime minister more than once.

Income: The prime minister receives an annual salary as a member of parliament, plus an additional amount for being prime minister. The prime minister lives in the official residence in Ottawa, Ontario.

Succession: If a prime minister dies, resigns, is disabled, or is removed from office, the governor general appoints a successor.

minister acts as the voice of the nation. He or she directs foreign policy, serves as the leader of the governing party, and, with the aid of a House leader, guides debates and discussions in the House.

By means of appointments to various offices, the prime minister shapes the character of the federal government. For example, the prime minister, through recommendations to the governor general, chooses Cabinet ministers, ambassadors, judges, military leaders, and other high government officials.



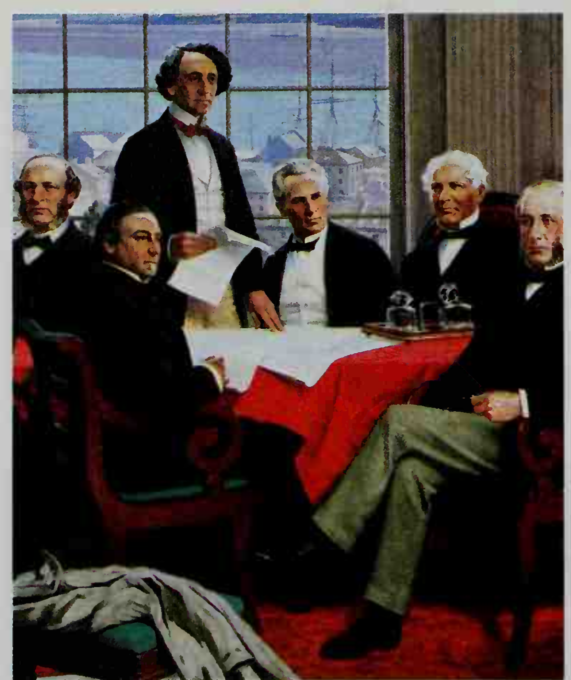
National Capital Commission. Ottawa, Canada

The prime minister's official residence overlooks the Ottawa River in Ottawa, Ontario. The house was completed in 1951 and is maintained by the Canadian government.

The prime minister lives in the official residence in Ottawa, Ontario. The house is maintained by the Canadian government.

History. Canada was headed by a British governor until the mid-1800's. Beginning in 1848, several colonies won a measure of self-government and chose their own premiers.

Born	Birthplace	Age when sworn into office	Occupation or profession	College or university
Jan. 11, 1815	Glasgow, Scotland	52	Lawyer	
Jan. 28, 1822	Logierait, Scotland	51	Building contractor	
Jan. 11, 1815	Glasgow, Scotland	63	Lawyer	
March 12, 1821	St. Andrews, Lower Canada (now Quebec)	70	Lawyer	McGill
Nov. 10, 1844	Halifax, Nova Scotia	48	Lawyer	
Dec. 27, 1823	Rickinghall, England	70	Newspaper editor	
July 2, 1821	Amherst, Nova Scotia	74	Doctor	Acadia
Nov. 20, 1841	St. Lin (now Laurentides), Quebec	54	Lawyer	L'Assomption
June 26, 1854	Grand Pré, Nova Scotia	57	Lawyer	
June 26, 1854	Grand Pré, Nova Scotia	63	Lawyer	
June 16, 1874	near St. Mary's, Ontario	46	Lawyer	Toronto
Dec. 17, 1874	Berlin (now Kitchener), Ontario	47	Public servant	Toronto
June 16, 1874	near St. Mary's, Ontario	52	Lawyer	Toronto
Dec. 17, 1874	Berlin (now Kitchener), Ontario	51	Public servant	Toronto
July 3, 1870	near Hopewell Cape, New Brunswick	60	Lawyer	Dalhousie
Dec. 17, 1874	Berlin (now Kitchener), Ontario	60	Public servant	Toronto
Feb. 1, 1882	Compton, Quebec	66	Lawyer	Laval
Sept. 18, 1895	Neustadt, Ontario	61	Lawyer	Saskatchewan
April 23, 1897	Toronto, Ontario	65	Diplomat	Toronto
Oct. 18, 1919	Montreal, Quebec	48	Lawyer	Jean-de-Brébeuf
June 5, 1939	High River, Alberta	39	Political worker	Alberta
Oct. 18, 1919	Montreal, Quebec	60	Lawyer	Jean-de-Brébeuf
June 7, 1929	Richmond, England	55	Lawyer	British Columbia
March 20, 1939	Baie-Comeau, Quebec	45	Lawyer	St. Francis Xavier
March 10, 1947	Port Alberni, British Columbia	46	Lawyer	British Columbia
Jan. 11, 1934	Shawinigan, Quebec	59	Lawyer	Laval



Detail of *Fathers of the Confederation* (1864), an oil painting on canvas by J. D. Kelly; Confederation Life Collection, Toronto, Canada

Canada's first prime minister was Sir John A. Macdonald, *standing.* He is shown at the Quebec Conference of 1864, which led to the formation of the Dominion of Canada in 1867.

Interesting facts about prime ministers

Who was Canada's first prime minister? Macdonald.
Who was the first French Canadian to serve as prime minister? Laurier.
Which prime minister served the most years? King, 21 years.
Who served the most years continuously as prime minister? Laurier, 15 years.
Which prime minister served the shortest term? Tupper, 10 weeks.
Which prime minister served the most nonconsecutive terms? King, 3.
Who was the first female prime minister? Campbell.
Which prime minister was the first Canadian to win the Nobel Peace Prize? Pearson.
Who was the oldest person to become prime minister? Tupper, 74.
Who was the youngest person to become prime minister? Clark, 39.
Which prime ministers died in office? Macdonald and Thompson.
Which prime minister married while in office? Trudeau.
Which prime ministers never married? Bennett and King.
Which prime minister was a former president of the United Nations General Assembly? Pearson.
Who was the first Liberal prime minister? Mackenzie.
Which prime ministers have the same birthdays? Macdonald and Chrétien, January 11.
Which prime minister was a physician? Tupper.
Who was the first prime minister born in what is now Canada? Abbott.

The Dominion of Canada was founded in 1867, and Sir John A. Macdonald became Canada's first prime minister. During his long time in office, Canada added the provinces of British Columbia, Manitoba, and Prince Edward Island, and the Northwest Territories. Alexander Mackenzie, who served from 1873 to 1878, established the Supreme Court of Canada in 1875.

Sir Wilfrid Laurier was the first French-speaking prime minister. Laurier held office from 1896 to 1911. The provinces of Alberta and Saskatchewan were created during this period. Laurier worked to unify the English-speaking and French-speaking people of Canada. Under Sir Robert L. Borden, who served from 1911 to 1920, the government fought World War I and imposed a military draft.

Canada became an independent power in international relations while W. L. Mackenzie King was prime minister. He served from 1921 to 1926, 1926 to 1930, and 1935 to 1948. Richard B. Bennett, who led the nation from 1930 to 1935, helped set up Canada's central bank and publicly owned radio broadcasting system.

Louis S. St. Laurent held office from 1948 to 1957 and played an important role in the establishment of the North Atlantic Treaty Organization (NATO). John G. Diefenbaker, the prime minister from 1957 to 1963, introduced Canada's first bill of rights. Lester B. Pearson, who served from 1963 to 1968, was a former diplomat and the first Canadian to win the Nobel Peace Prize. He received the award in 1957 for his achievements as an international statesman.

Pierre Trudeau, leader of the Liberal Party, became prime minister in 1968. Trudeau worked to improve relations between English- and French-speaking Canadians. Joe Clark of the Progressive Conservative Party succeeded him as prime minister in 1979. Trudeau became prime minister again in 1980 and resigned in 1984. He was succeeded by John Turner, another Liberal. The Progressive Conservatives won the national election of 1984, and Brian Mulroney became prime minister. Mulroney resigned in June 1993, and Kim Campbell, also a Progressive Conservative, became Canada's first woman prime minister. However, the Liberal Party won the national election held in October 1993, and Liberal leader Jean Chrétien succeeded Campbell as prime minister.

Norman Ward

Additional resources

Bliss, Michael. *Right Honourable Men: The Descent of Canadian Politics from Macdonald to Mulroney.* HarperCollins, 1994.
Donaldson, Gordon. *The Prime Ministers of Canada.* Doubleday, 1994.
Hancock, Pat. *The Kids Book of Canadian Prime Ministers.* Kids Can Pr., 1998. Younger readers.
Martin, Lawrence. *The Presidents and the Prime Ministers: Washington and Ottawa Face to Face.* 1982. Reprint. PaperJacks, 1983.

Prime number. See Factor; Number theory.

Prime rate. See Interest (The prime rate).

Primogeniture, *PRY muh JEHN uh chur,* is a system of inheritance widely used in Europe for hundreds of years. Under this system, the oldest child in a family, and often the oldest son, has the sole right to inherit land and other possessions from the parents. Primogeniture first developed under the feudal system (see **Feudalism**). In England and other countries, the oldest child in the royal family became the successor to the throne. The system kept the nobles' large landholdings from being broken up among their children into many small estates.

It also preserved the social position and prestige of the noble families. Peasants and other landholders also practiced primogeniture.

Primogeniture gradually disappeared in Europe, except among ruling families, as the feudal system died out. It came to an end in the United Kingdom in 1925, except for the royal family. The United States abolished primogeniture by law. Bryce Lyon

See also **Jefferson, Thomas** (Virginia lawmaker).

Primrose is the common name of a group of plants that usually flower in the early spring. Cultivated primroses are considered choice ornamental garden flowers. Many of these have been developed from the *common primrose,* which grows naturally in woods and meadows of Europe.

The common primrose has deeply veined leaves and yellowish-white flowers. Other varieties of primroses have flowers that range from yellow to pink, red, lilac, and purple. Some primroses make excellent potted plants for the window garden. Others are grown in greenhouses. The primrose is the flower for the month of February.

Primroses in the garden need shade and rich, moist loam. To start from seed, plant in February in a mixture of sand, loam, and leaf mold. The young plants should be set out in the open in May, placed in a permanent flower bed in September, and protected over winter. They will flower the following spring. Melinda F. Denton

Scientific classification. Primroses belong to the primrose family, Primulaceae. The scientific name for the common primrose is *Primula vulgaris.* Among the greenhouse and window varieties are the Chinese primrose, *P. sinensis,* and the Japanese, *P. japonica.*



E. R. Degginger

Red primroses



Grant Heilman

Yellow primroses

See also **Cowslip; Cyclamen; Flower** (picture: Garden perennials).

Primrose, William (1904-1982), a Scottish violist, became known for his outstanding performances in solo concert. He made his debut at Albert Hall, London, in 1923. From 1930 to 1935, he toured Europe and the Americas as violist of the London String Quartet, and, later, as a solo violist. In 1937, he became a violist with the National Broadcasting Company Symphony Orchestra conducted by Arturo Toscanini, and later was soloist. In 1938, he founded his own quartet.

Primrose taught viola at the Curtis Institute of Music and the Juilliard School of Music. He was born in Glasgow, Scotland, on Aug. 23, 1904, and studied with Eugène Ysaÿe. Primrose died on May 1, 1982.
Stephen Clapp

Prince is a title of the highest rank of the nobility. The word comes from the Latin *princeps,* meaning *first. Princeps* was used as a title for civil and military officials among the ancient Romans. The German Visigoth and Lombard tribes that settled in the Roman Empire used *prince* to mean independent authority. The crusaders followed this practice when they set up governments in the Near East.

In modern times, the title *prince* or *princess* can be used in many ways. It is the title of the ruler of the principality of Liechtenstein. In the United Kingdom, only the eldest son of the ruler has a legal right to the title of prince, and only after the ruler has created him Prince of Wales. The oldest daughter may be granted the title Princess Royal. As a mark of courtesy, other members of the royal family, and they alone, are called prince or princess. In France, male members of the former royal Bourbon family are called prince. In Italy, the title is commonly used by the heads of many of the great Italian families. Joel T. Rosenthal

Prince Albert (pop. 34,291), is an important center of commercial trading and of tourism in central Saskatchewan. It lies on the North Saskatchewan River near the Prince Albert National Park (see **Saskatchewan** [political map]). The city's industries include bottling; welding and fabricating; and the manufacture of pulp and paper, and infrared heating pads. Regional airlines connect Prince Albert to Saskatoon and Regina, Saskatchewan.

Prince Albert was founded in 1866 and incorporated as a city in 1904. It has a mayor-council form of government. Wayne J. Roznowsky

Prince Albert National Park. See **Canada** (National park system).

Prince consort is the husband of a reigning queen. In countries where the daughter of a king may inherit the throne, her husband does not have the title of king. Denmark, the Netherlands, and the United Kingdom are among the countries that allow a woman to rule.



Barrett & MacKay, Masterfile

Early morning on a farm near the village of Clyde River

Prince Edward Island

Prince Edward Island is the smallest but most thickly populated province of Canada. Its people usually call their province "The Island" or simply use its initials, "P.E.I." The people live in small, scattered communities. But the average number of people to the square mile or square kilometer is greater than in any other province. Charlottetown is the capital and largest city of Prince Edward Island.

Prince Edward Island is the only Canadian province that is entirely separated from the North American mainland. The island lies in the Gulf of St. Lawrence, a rich fishing area off the Atlantic coast of Canada. Lobsters are the most valuable catch of the island's fishing industry. The province's oysters are known for their delicious flavor. Fishing crews from the island also catch cod, crabs, flounder, hake, herring, mackerel, scallops, and tuna.

The chief sources of employment and income for the people of the island are the service industries. Spending by tourists benefits such service industries as transportation and retail trade. Agriculture is also an important economic activity in the province. The island's fertile soil is its greatest natural resource, and farms cover nearly half of the province. Each year, Prince Edward Island produces large numbers of potatoes, its chief crop. Other important farm products include beef cattle, blueberries, hogs, and milk.

The island lacks valuable minerals and cheap sources of power. In addition, transportation to and from the mainland is expensive. For these reasons, manufacturing on Prince Edward Island has developed slowly. Food processing is the leading manufacturing activity. The production of aircraft parts is also important.

Prince Edward Island has long stretches of red or white sandy beaches along its coasts, with warm currents offshore. Few people live far from a good beach.

The island's streams are well stocked with fish. Many

The contributors of this article are Harry Baglole, Director of the Institute of Island Studies at the University of Prince Edward Island; and David Weale, Professor of History at the University of Prince Edward Island.

Barrett & MacKay

Charlottetown, the province's capital

people enjoy sailing, surfing, and fishing off the coasts of the province. The island also has many fine golf courses. All of these attractions bring hundreds of thousands of vacationers to Prince Edward Island every year.

Micmac Indians lived on what is now Prince Edward Island long before white people arrived. The Indians called the island *Abegweit* (cradled on the waves). A Micmac legend tells how the god Glooscap finished painting the beauties of the world. Then he dipped his brush into a mixture of all the colors and created Abegweit, his favorite island.

The British named the island in honor of a son of King George III. Prince Edward Island's fertile red soil and its location in the Gulf of St. Lawrence have given it two nicknames—the *Garden of the Gulf* and the *Million Acre Farm.* In addition, it is often called *Spud Island* because of its large potato production.

Prince Edward Island is one of the Atlantic Provinces. For its relationship to the other Canadian provinces, see the articles on **Atlantic provinces; Canada; Canada, Government of; Canada, History of.**

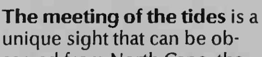
Interesting facts about Prince Edward Island

WORLD BOOK illustrations by Kevin Chadwick

Irish moss, Canada's most valuable commercial seaweed, is harvested off the coast of Prince Edward Island. The island exports about 6,000 tons (5,400 metric tons) of Irish moss each year to manufacturers throughout the world. The manufacturers extract a substance called *carrageenin* from the moss. Carrageenin is a thickening agent used in cosmetics and in food products such as ice cream, pudding, and cake mixes.

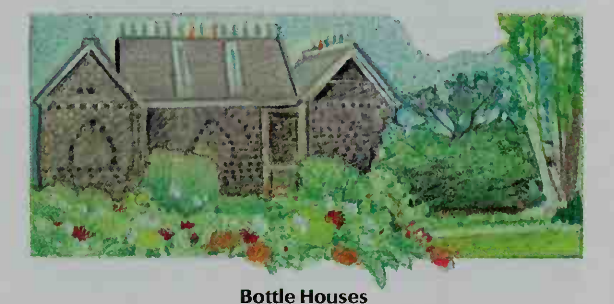


Irish moss



The meeting of the tides is a unique sight that can be observed from North Cape, the northernmost point of the province. There the tides of the Northumberland Strait overlap with those of the Gulf of St. Lawrence. The phenomenon is especially evident at high tide, but the line where the two tides meet is visible throughout the day.

The Bottle Houses at Cape Egmont, built between 1980 and 1983, are houses made from many kinds of bottles. The largest of the three houses measures 18 feet by 24 feet (5.5 meters by 7.3 meters) and is made from 12,000 bottles.



Bottle Houses



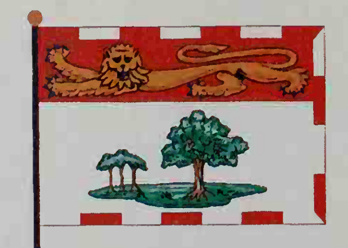
Wayne Barrett, Prince Edward Island Tourism

Dock at North Lake, a fishing village near East Point

Prince Edward Island in brief

Symbols of Prince Edward Island

The provincial flag, adopted in 1964, bears an adaptation of the coat of arms. On the coat of arms, adopted in 1905, the British lion symbolizes the province's ties with the United Kingdom. Three oak saplings represent the three counties of Prince Edward Island. The large oak tree stands for the United Kingdom.



Provincial flag



Prince Edward Island (brown) ranks as the smallest of all the provinces. It is one of the Atlantic Provinces (yellow).



Province House is in Charlottetown, the capital of Prince Edward Island since 1768.

General information

Entered the Dominion: July 1, 1873, the 7th province.
Provincial abbreviation: PE (postal).
Provincial motto: *Parva Sub Ingenti* (The Small Under the Protection of the Great).
Provincial song: "The Island Hymn." Words by Lucy Maud Montgomery; music by Lawrence W. Watson.

Land and climate

Area: 2,185 mi^2 (5,660 km^2).
Elevation: *Highest*—465 ft (142 m) above sea level in Queens County. *Lowest*—sea level.
Coastline: 688 mi (1,107 km).
Record high temperature: 98 °F (37 °C) at Charlottetown on Aug. 19, 1935.
Record low temperature: −35 °F (−37 °C) at Kilmahumaig, near Alberton, on Jan. 26, 1884.
Average July temperature: 66 °F (19 °C).
Average January temperature: 19 °F (−7 °C).
Average yearly precipitation: 44 in (111 cm).

Important dates

- **1534** Jacques Cartier, a French explorer, landed on Prince Edward Island.
- **1603** Samuel de Champlain claimed the island for France and named it Île St. Jean.
- **1763** Britain acquired the island from France in the Treaty of Paris and changed its name to St. John's Island.
- **1769** St. John's Island, which had been part of Nova Scotia, became a separate British colony.



Province of Prince Edward Island

Provincial coat of arms



Provincial seal



Floral emblem
Lady's-slipper

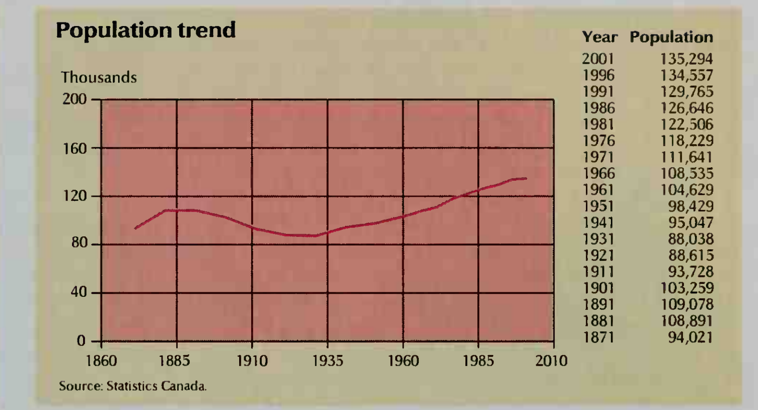
People

Population: 135,294 (2001 census)
Rank among the provinces: 10th
Density: 62 persons per mi² (24 per km²), provinces average 13 per mi² (5 per km²)
Distribution: 55 percent rural, 45 percent urban
Largest cities and towns*

Charlottetown	32,245
Summerside	14,654
Stratford	6,314
Cornwall	4,412
Montague	1,945
Kensington	1,385

*2001 census.
Source: Statistics Canada.

Population trend



Year	Population
2001	135,294
1996	134,557
1991	129,765
1986	126,646
1981	122,506
1976	118,229
1971	111,641
1966	108,535
1961	104,629
1951	98,429
1941	95,047
1931	88,038
1921	88,615
1911	93,728
1901	103,259
1891	109,078
1881	108,891
1871	94,021

Source: Statistics Canada.

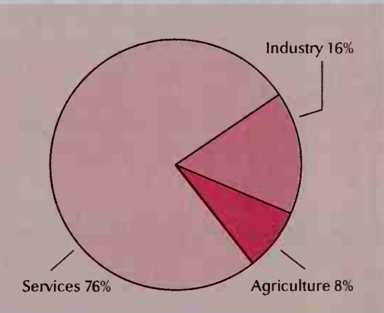
Economy

Chief products

Agriculture: potatoes, milk, beef cattle, hogs, tobacco, barley, berries, vegetables.
Fishing industry: lobsters, mussels.
Manufacturing: food products.

Gross domestic product

Value of goods and services produced in 2000: $2,825,000,000.* *Services* include community, business, and personal services; finance; government; trade; and transportation and communication. *Industry* includes construction, manufacturing, mining, and utilities. *Agriculture* includes agriculture, fishing, and forestry.



*Canadian dollars.
Source: Statistics Canada.

Government

Provincial government

Premier: term of up to 5 years
Members of the Legislative Assembly: 27; terms of up to 5 years

Federal government

Members of the House of Commons: 4
Senators: 4

Sources of information

For information on tourism in Prince Edward Island, write to: Prince Edward Island Department of Tourism, P.O. Box 2000, Charlottetown, PE C1A 7N8. The Web site at www.gov.pe.ca/visitorsguide is also a good source of tourist information. For information on the province's economy, write to: Provincial Treasury, P.O. Box 2000, Charlottetown, PE C1A 7N8. The treasury's Web site at www.gov.pe.ca/pt is also useful. For information on the government and history of Prince Edward Island, write to: Island Information Service, P.O. Box 2000, Charlottetown, PE C1A 7N8. The government's Web site at www.gov.pe.ca also provides a helpful gateway to information on the island's government and history.

1799 The colony was renamed Prince Edward Island.

1864 The first Confederation Conference was held in Charlottetown to discuss a federal union.

1873 Prince Edward Island became the seventh province on July 1.

1997 Confederation Bridge, which connects Prince Edward Island and the Canadian mainland, was completed.

People

Population. The 2001 Canadian census reported that Prince Edward Island had 135,294 people. The population of the province had increased by less than 1 percent over the 1996 figure of 134,557.

About 45 percent of Prince Edward Island's people live in urban areas. About 40 percent live in Charlottetown and its surrounding area. Summerside is the province's only other city. The province has about 50 incorporated towns and villages, each of which has fewer than 10,000 people. See **Charlottetown; Borden.**

Almost all the province's people were born in Canada. About three-fourths of the people have some British or Irish ancestry, and nearly all the islanders speak English. About one-fourth of the island's people have some French or Acadian ancestry. French is spoken in a few small communities, especially in the Evangeline region in the western part of the province. About 400 Micmac Indians live on reservations in the province.

Schools. The first schools on the island were established during the early 1800's. In 1852, the Free Education Act created a property tax to provide funds for school costs. The province established a Central Board of Education in 1877 and a Department of Education in 1945. The minister of education is the head of the department.

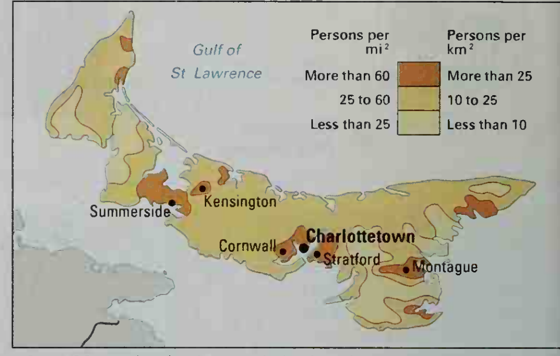
Today, provincial law provides for free public education for all children from ages 6 to 20 until the completion of high school. However, a child may attend a private school or may be educated at home with the approval of the provincial minister of education. Most schools offer instruction in English, but some offer instruction in French. For the number of students and teachers on Prince Edward Island, see **Education** (table).

The province has one university, the University of Prince Edward Island in Charlottetown. The school was established in 1969. In that year, the faculties and students of St. Dunstan's University, founded in 1855, and Prince of Wales College, founded in 1834, joined to become the new University of Prince Edward Island. The Atlantic Veterinary College is on the university's campus. Holland College, a public community college, has locations throughout the province. It offers post-secondary and adult education programs in a variety of fields.

Libraries and museums. In 1933, Prince Edward Island established Canada's first provincial library system. The Confederation Centre of the Arts, which was opened in Charlottetown in 1964, includes an art gallery, theaters, and a public library. The province has many branch libraries and community historical museums.

Population density

Prince Edward Island has fewer people than any other Canadian province, but because of its small size it is the most densely populated province. Charlottetown is the capital.



WORLD BOOK map; based on the *National Atlas of Canada*

Prince Edward Island map index

Counties

Name	Population	Map key
Kings	19,180	E 9
Prince	44,495	D 4
Queens	71,619	E 7

Cities, towns, and other populated places

Name	Population	Map key
Abney		G 9
Abrams Village	342	E 4
Albany		E 5
Alberton	1,115	C 4
Alexandra*		F 8
Alliston		G 9
Alma		B 4
Anglo Tignish		B 4
Argyle Shore*		F 7
Augustine Cove*		F 5
Bangor		E 9
Beach Point		G 10
Bear River		E 10
Bedeque	154	E 5
Belle River		G 8
Bloomfield		C 3
Bonshaw		F 6
Borden†	798	F 5
Brackley	358	E 7
Brackley Beach*		D 7
Breadalbane	170	E 6
Brudenell*		F 9
Bunbury		F 7
Burton		C 3
Canoe Cove*		F 7
Cape Egmont		E 4
Cape Traverse		F 5
Cape Wolfe		C 3
Cardigan	382	F 9
Carleton†		F 5
Carleton Siding†		F 5
Cascumpec		C 4
Central Bedeque*	186	E 5
Charlottetown°	32,245	F 7
Clermont*		E 5
Clinton		E 6
Clyde River	581	F 7
Coleman		C 3
Conway*		C 4
Cornwall	4,412	F 7
Covehead Road		E 7
Crapaud	382	F 6
Cross Roads		F 7
Darnley		D 5
Dundas		E 10
Dunstaffnage*		E 8
East Royalty*		E 7
Ebenezer		E 7
Eldon		F 8
Ellerslie		D 4
Elmira		E 11
Elmsdale		C 3
Emerald [Junction]		E 6
Emyvale*		F 6
Flat River		G 8
Fort Augustus*		E 8
Freeland		C 4
Freetown*		E 6
Gaspereaux		F 10
Georgetown°	721	F 9
Grand Tracadie		E 8
Hampshire*		E 7
Hampton		F 6
Harrington*		E 7
Hazelbrook*		F 8
Hillsborough Park*		E 7
Howlan		C 3
Hunter River	354	E 6
Indian River		D 5
Iona		F 8
Johnstons River*		E 8
Kensington	1,385	E 5
Kingsboro		E 11
Kinkora	315	E 5
Knutsford		C 3
Lennox Island Indian Reserve 1	261	D 4
Linkletter*	332	E 5
Little Pond		E 10
Long Creek*		F 7
Lower Montague		F 9
Loyalist*		E 7
Malpeque*		D 5
Margate		E 6
Marshfield		E 7
Mayfield		E 6
Meadowbank*	367	F 7
Mermaid*		E 8
Middleton		E 5
Miltonvale Park*	1,185	E 7
Miminegash	188	B 3
Miscouche	766	E 5
Montague	1,945	F 9
Montrose		B 4
Morell	332	E 9
Morell Indian Reserve	10	E 9
Mount Carmel		E 4
Mount Herbert		F 8
Mount Pleasant*		D 4
Mount Stewart	312	E 8
Murray Harbour	357	G 10
Murray Harbour North		G 10
Murray River	435	G 9
Nail Pond		B 4
New Annan*		E 5
New Glasgow		E 6
New Haven		F 7
New Perth*		F 9
Nine Mile Creek		F 7
Norboro		E 6
North Bedeque		E 5
North Lake		E 11
North Milton		E 7
Northport		C 4
North River*		F 7
North Rustico	637	E 7
North Tryon*		F 6
North Wiltshire*		F 7
Northam		D 4
O'Leary	860	C 3
Orwell		F 8
Oyster Bed Bridge		E 7
Palmer Road		B 3
Parkdale		F 7
Peters Road*		G 9
Pinette		G 8
Piusville		C 3
Pleasant View*		B 3
Poplar Grove		C 4
Pownal		F 8
Richmond		D 4
Rocky Point	42	F 7
Rollo Bay		E 10
Roseneath*		F 9
St. Chrysostome		D 4
St. Edward		B 3
St. Eleanors		E 5
St. Felix		B 4
St. Louis	98	B 4
St. Nicholas-Muddy Creek		E 4
St. Peters Bay*	267	E 9
Scotchfort Indian Reserve	105	E 8
Sea View		D 6
Seacow Pond		A 4
Sherbrooke	178	E 5
Sherwood		E 7
Skinners Pond		B 4
Souris	1,248	E 11
Souris West		E 10
South Rustico		E 7
Southport		F 7
Southwest Lot 16		D 4
Spring Valley		D 5
Stanhope		E 7
Stanley Bridge		D 6
Sturgeon		F 9
Summerside°	14,654	E 5
Tignish	831	B 4
Travellers Rest		E 5
Tyne Valley	223	D 4
Union Road*	225	E 7
Unionvale		C 3
Urbainville		E 4
Vernon Bridge		F 8
Victoria	119	F 6
Victoria Cross*		F 9
Warren Grove*	332	F 7
Wellington	382	E 4
West Devon		C 4
West Royalty		F 7
Wilmot		G 9
Wilmot Valley		E 5
Winsloe North		E 7
Winsloe South*	240	E 7
Wood Islands		G 9
York		E 7

*Does not appear on map; key shows general location.
Source: 2001 census. Places without populations are unincorporated.
†In 1995, Borden annexed Carleton and Carleton Siding and became known as Borden-Carleton.
°County seat.



Prince Edward Island political map
Park or other recreation area
Indian reserve
Provincial boundary
County boundary
KINGS County name
Provincial capital
County seat
City or town
Major airport
Park or other area
Point of interest
Railroad
Highways:
Expressway
Other road
Trans-Canada
Provincial
Transverse mercator projection
WORLD BOOK map
North
64° West Longitude
63
62
47° North Latitude
46
Gulf of Saint Lawrence
Northumberland Strait
Egmont Bay
Kouchibouguac Bay
KOUCHIBOUGUAC NATIONAL PARK
POINT ESCUMINAC
Point Sapin
Richibucto
Buctouche
Shediac
Moncton
Dorchester
Sackville
NEW BRUNSWICK
NOVA SCOTIA
Port Elgin
Baie Verte
Bayfield
COLDSPRING HEAD
CONFEDERATION BRIDGE
NORTH CAPE
Seacow Pond
Nail Pond
Anglo Tignish
Tignish
Skinners Pond
Waterford
Palmer Road
St. Felix
CAPE GAGE
Miminegash
St. Louis
St. Edward
Alma
Montrose
JACQUES CARTIER PROVINCIAL PARK
Elmsdale
Alberton
Campbellton
Pigsville
Northport
Burton
Bloomfield
Cascumpec Bay
Bloomfield Corner
Cascumpec
Cape Wolfe
Howlan
O'Leary
Unionvale
Conway Narrows
Knutsford
Carleton
Springfield West
Coleman
Freeland
Brae
West Devon
Poplar Grove
CEDAR DUNES PROVINCIAL PARK
Glenwood
GREEN PARK PROVINCIAL PARK
LENNOX ISLAND
LENNOX ISLAND INDIAN RESERVE 1
WEST POINT
West Point
Ellerslie
HOG ISLAND
Malpeque Harbour
Enmore
Port Hill
PROFITTS POINT
Tyne Valley
Malpeque Bay
CABOT BEACH PROVINCIAL PARK
Sea View
PRINCE
Northam
COURTIN ISLAND
Spring Valley
Darnley
New London Bay
St. Chrysostome
Richmond
Cavendish
ORBY HEAD
PRINCE EDWARD ISLAND NATIONAL PARK
Egmont Bay
South West
Stanley Bridge
Indian River
Lot 16
Mayfield
Urbainville
Wellington
WOODLEIGH REPLICAS
Margate
North Rustico
Abrams Village
Miscouche
Clinton
CAPE STANHOPE
St. Nicholas
Sherbrooke
Kensington
Glasgow
Bed Bridge
Stanhope
Grand Tracadie
CAPE EGMONT
Cape Egmont
St. Eleanors
Summerside
Wilmot Valley
Norboro
South Rustico
Winsloe North
Mount Carmel
Bedeque Bay
Travellers Rest
Emerald
Breadalbane
Hunter River
Covehead Road
Blooming Point
Lower Bedeque
Bedeque
North Bedeque
Kinkora
Shamrock
QUEENS
Ebenezer
North Milton
York
Tracadie
SCOTCHFORT INDIAN RESERVE
SEACOW HEAD
Sevenmile Bay
Middleton
Albany
Rose Valley
Winsloe
Brackley
Marshfield
Hillsborough River
Borden
Carleton Siding
Kellys Cross
West Royalty
Sherwood
Charlottetown
Parkdale
Bunbury
Cape Traverse
Crapaud
Hampton
Victoria
Victoria Harbour
BLACK POINT
Bonshaw
New Haven
Clyde River
Cornwall
Rocky Point
Southport
Cross Roads
Mount Herbert
Pownal
Pownal Bay
STRATHGARTNEY PROVINCIAL PARK
Nine Mile Creek
FORT AMHERST-PORT LA JOYE NATIONAL HISTORIC SITE
ST PETERS ISLAND
Hillsborough Bay
Mount Buchanan
POINT PRIM
LORD SELKIRK PROVINCIAL PARK
Flat River
BIG POINT
Belle River
Wood Islands
Pinette
Belfast
Orwell Bay
Vernon Bridge
Eldon
Iona
Orwell
Cherry Valley
Millview
Vernon River
Lower Montague
Montague
Lorne Valley
Watervale
Mount Stewart
Morell
MORELL INDIAN RESERVE
Bangor
KINGS
Primrose
Dundas
Cardigan
BRUDENELL PROVINCIAL PARK
Georgetown
Cardigan Bay
BOUGHTON ISLAND
Georgetown Harbour
PANMURE ISLAND
PANMURE ISLAND PROVINCIAL PARK
Sturgeon
CAPE SHARP
Gaspereaux
Brooklyn
Alliston
Murray Harbour North
Glenwilliam
Murray River
Wilmot
Beach Point
MURRAY HEAD
Murray Harbour
Abney
Little Sands
NORTHUMBERLAND PROVINCIAL PARK
CABLE HEAD
St. Peters Bay
Monticello
CAMPBELLS COVE PROVINCIAL PARK
ST. PETERS PROVINCIAL PARK
St. Peters
Bear River
St. Charles
Rollo Bay
Fortune Bridge
New Zealand
Bothwell
Elmira
North Lake
SURVEYOR POINT
EAST POINT
Souris West
Kingsboro
RED POINT PROVINCIAL PARK
Souris
Rollo Bay
Howe Bay
Little Pond
Annandale
140 Miles
220 Kilometers

Over a million vacationers visit Prince Edward Island each summer. Many visitors camp or go swimming, sailing, kayaking, or deep-sea fishing in the warm coastal waters. People go trout fishing or canoeing in inland streams. Hikers and bicyclists travel across the island along the Confederation Trail. Golfing is also popular.

Several annual events take place in the summer. The Charlottetown Festival runs from June to October. The highlight of this theatrical festival is the musical play *Anne of Green Gables,* based on the book by the Prince Edward Island novelist Lucy Maud Montgomery. Harness racing is featured at the Charlottetown Driving Park and the Summerside Raceway. Country style lobster suppers are served daily in several communities.



© John Sylvester, Tourism Prince Edward Island

Green Gables House at Prince Edward Island National Park

Places to visit

Following are brief descriptions of some of Prince Edward Island's many interesting places to visit:

Basin Head Fisheries Museum, near Souris, captures the history of the island's fishing industry with artifacts and photographs. A boardwalk provides access to the nearby white-sand Basin Head beach.

Confederation Centre of the Arts, in Charlottetown, was built in 1964 to commemorate the 100th anniversary of the meeting of the Fathers of Confederation. It has an art gallery/museum, a library, memorial hall, theaters, a restaurant, and a gift shop.

Harbourfront Jubilee Theatre, on Summerside's scenic waterfront, features dramatic and musical theater productions and renowned touring artists.

Lennox Island, in Malpeque Bay, is a Micmac Indian reservation.

Orwell Corner Historic Village, in Orwell, is a reproduction of a small agricultural community of the 1890's. The village also hosts a number of recreational and musical events throughout the summer and fall.

P.E.I. Preserve Co., in New Glasgow, lets visitors view the manufacture of preserves and a variety of food specialty items.

Woodleigh Replicas and Gardens, near Burlington, has many reproductions of British castles, churches, and homes.

National parks and sites. Prince Edward Island National Park includes the house that served as the setting of the story *Anne of Green Gables.* Every year, thousands of people visit this house. The park also includes a spectacular dune system on Greenwich, a peninsula that separates St. Peters Bay from the Gulf of St. Lawrence. See **Canada** (National parks).

Fort Amherst-Port La Joye National Historic Site, near Charlottetown, is the site of a British fort built in 1758 and an earlier French settlement. It includes a small historical museum.

Province House National Historic Site in Charlottetown includes the Confederation Chamber. This room, called the *Birthplace of Canada,* is furnished as it was in 1864 when the Fathers of Confederation planned the union of Canada there.

Provincial parks. Prince Edward Island established its park system in 1958. Today, it has about 30 provincial parks. Many of them have native birds, flowers, or marine life. Some have hiking trails. For information on any of the provincial parks, write to Visitor Services, P.O. Box 940, Charlottetown, PEI C1A 7M5. The Web site at www.gov.pe.ca/visitorsguide/explore/parks also provides information on the island's provincial parks.

Annual events

May
Ceili at the Irish Hall in Charlottetown; Indoor Scottish Ceilidh Concert in Richmond (May-October).

June
Summerside Highland Gathering; Bridgefest in Borden-Carleton; Charlottetown Festival (June-October).

July
Festival of Lights in Charlottetown; Street Rod Show 'n' Shine in Montague; Souris Regatta; Summerside Lobster Carnival; Potato Blossom Festival in O'Leary; Northumberland Provincial Fisheries Festival in Murray River; Crapaud Exhibition; Charlottetown Race Week; Ceilidhs (traditional Scottish gatherings) in Orwell (July and August); Victoria Playhouse Summer Festival (July to September); Larry Gorman Folk Festival in Tyne Valley (late July or early August).

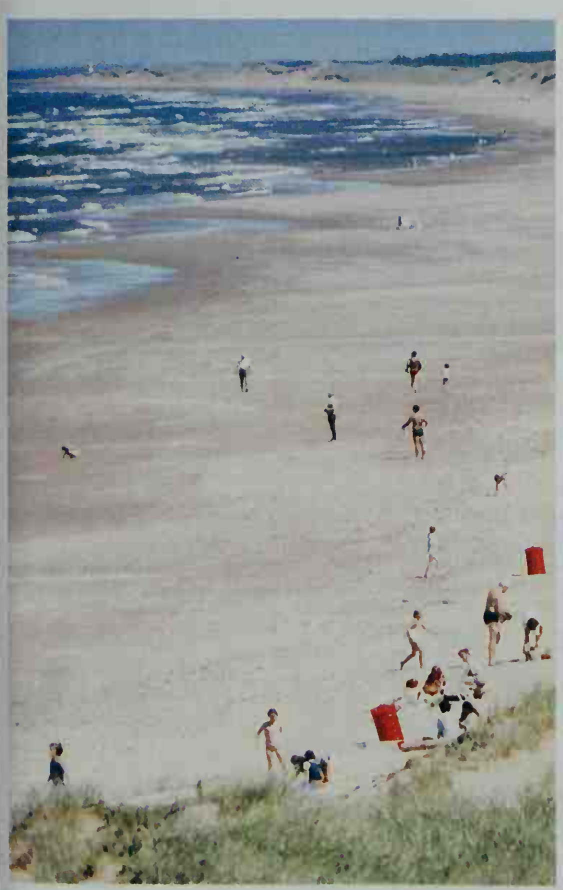
August
Tyne Valley Oyster Festival (early August); Fête Nationale des Acadiens in Abrams Village; Community Harvest Festival in Kensington; Plowing Match and Agricultural Fair in Dundas; Highland Games and Gathering of the Clans in Eldon; Old Home Week Provincial Exhibition in Charlottetown; Festival of the Fathers in Charlottetown; Lucy Maud Montgomery Festival in Cavendish and area.

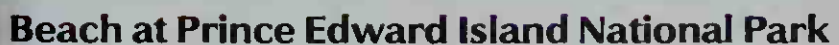
September
Acadian Festival and Agricultural Exhibition in Abrams Village (early September); Prince Edward Island International Shellfish Festival in Charlottetown; Cornwall Cornfest; Trailfest (island-wide); and the Prince Edward Island Studio Tour.



John de Visser, Masterfile

The Confederation Centre of the Arts in Charlottetown





Freeman Patterson, Masterfile

Beach at Prince Edward Island National Park



Gord Johnston, Prince Edward Island Tourism

Replica of St. Paul's Cathedral at Woodleigh



Cameramann International, Ltd.

Plowing Match and Fair in Dundas

Land and climate

Almost all the land of Prince Edward Island is a gently rolling plain. Forests cover about half the island. The province also has meadowland. The highest point rises 465 feet (142 meters) above sea level in Queens County. Many tidal inlets (called *rivers* locally) and deep bays indent the 688-mile (1,107-kilometer) coastline. Two of the bays, Hillsborough and Malpeque, nearly cut the island into three parts. Other major bodies of water along the island's shores include Bedeque, Cardigan, and Egmont bays. Low cliffs rise along the eastern and southern coasts. Lennox Island and several other small islands that belong to the province lie near the shores.

Northern grasses and wildflowers, such as black-eyed Susans, buttercups, daisies, and violets, thrive in the red soil of the island. About half of the land is used for farming. Small wood lots of beech, birch, evergreen, and maple trees dot the land. Wild orchards of apple and cherry trees grow in some areas.

The island has small game animals such as ducks, geese, Hungarian partridges, ring-necked pheasants,

Prince Edward Island terrain map

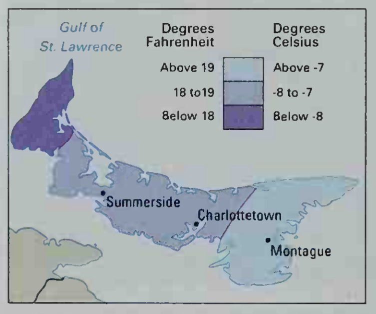
National park boundary
Boundary
Provincial capital
City or town
Elevation above sea level

Map index

WORLD BOOK map

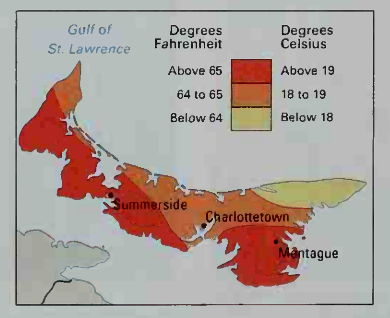
Average January temperatures

Winter temperatures are mostly even throughout the island. The southeast is slightly warmer.



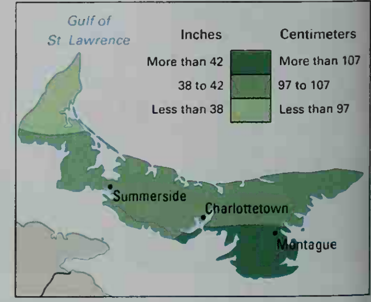
Average July temperatures

Summers are mild throughout Prince Edward Island. The northeastern corner is slightly cooler than the rest of the island.



Average yearly precipitation

There is only a small difference in precipitation throughout Prince Edward Island. The southeast is the wettest section.



WORLD BOOK maps; based on the *National Atlas of Canada.*



© First Light

Wildflowers thrive in the red soil of Prince Edward Island. This brightly colored field of lupines is in the southeastern part of the province.

ruffled grouse, and snowshoe hares. Coyotes, foxes, raccoons, and skunks are also common. Game fishes include Atlantic salmon and several kinds of trout. Clams, cod, crabs, hake, herring, lobsters, mackerel, mussels, oysters, and scallops live in the offshore waters.

The island has a milder climate than that of Canada's mainland. The province has an average temperature of 19 °F (−7 °C) in January and 66 °F (19 °C) in July. Kilmahumaig, near Alberton, had the lowest temperature, −35 °F (−37 °C), ever recorded in the province, on Jan. 26, 1884. Charlottetown had the highest temperature, 98 °F (37 °C), on Aug. 19, 1935. The province has an average *precipitation* (rain, melted snow, and other forms of moisture) of 44 inches (111 centimeters) and an average snowfall of 109 inches (276 centimeters) per year.

Average monthly weather

Charlottetown

	Temperatures °F High	°F Low	°C High	°C Low	Days of rain or snow
Jan.	27	10	−3	−12	18
Feb.	25	9	−4	−12	15
Mar.	34	19	1	−7	15
Apr.	43	28	7	−1	14
May	57	39	14	4	14
June	66	48	19	10	13
July	73	57	23	15	12
Aug.	73	55	23	14	12
Sept.	64	48	19	14	13
Oct.	54	39	13	6	14
Nov.	43	30	6	0	17
Dec.	32	18	−1	−7	20

Economy

Service establishments such as hotels, restaurants, and shops receive much income from the hundreds of thousands of tourists who visit Prince Edward Island each year. Manufacturing activities also employ many workers in the province. Farming and fishing have retained much of their traditional importance to Prince Edward Island's economy.

Natural resources. Rich red soil is the province's chief resource. This *loam* (mixture of clay, decayed matter, and sand) lies on beds of soft red or brown sandstones and shales. The loss of topsoil due to erosion is a serious problem on the island. Sand and gravel are the most valuable mined products on the island. Deposits of natural gas, uranium, and gold also have been found. The water supply comes mainly from wells.

Service industries account for the largest portion of Prince Edward Island's *gross domestic product* (GDP)—that is, the total value of all goods and services produced in the province in a year. The most important group of service industries is made up of community, business, and personal services. This group includes such services as education, health care, and the operation of hotels, resorts, and restaurants.

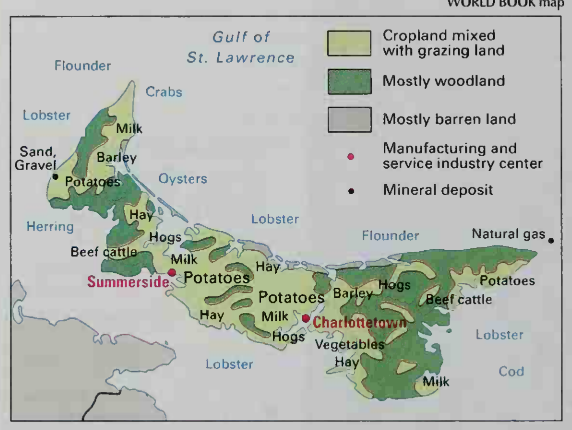
Finance, insurance, and real estate form the province's second-leading service industry group. The increasing popularity of Prince Edward Island as a site for vacation homes and resorts has led to rapid growth in real estate businesses.

Other service industries are government; wholesale and retail trade; and transportation and communication. The federal government provides large amounts of financial assistance to the people of Prince Edward Island

Economy of Prince Edward Island

This map shows the economic uses of land in Prince Edward Island and where the province's leading farm and mineral products are produced. Manufacturing centers are shown in red.

WORLD BOOK map



compared with most other provinces.

Agriculture. Farmland makes up almost half of Prince Edward Island's land area, a greater share than in any other province except Saskatchewan. The island has about 2,000 farms.

Potatoes, grown for table use and for seed, are the chief crop of Prince Edward Island. More than half of the potato crop is made into French fries at local processing plants. The province also ships many potatoes off the island, mainly to Ontario, Quebec, and the United States.

Other important crops on Prince Edward Island include barley, blueberries, and vegetables. Broad fields produce hay for the dairy industry. Livestock includes beef and dairy cattle and hogs.

Manufacturing. Goods manufactured on the island have a *value added by manufacture* of about 275 million Canadian dollars a year. This figure represents the difference between the value of raw materials and the value of finished products made from the raw materials. The processing of farm and fish products accounts for most of the province's manufacturing income. The manufacture of aircraft parts also has become a major activity. Companies in the province also produce printed materials, wood products, fabricated metal products, fertilizer, and medical instruments.

Fishing industry. Lobsters are by far Prince Edward Island's most important catch. Other catches include cod, crab, flounder, herring, and oysters. About 90 percent of the total catch is exported. More than half of all cultivated mussels produced in North America come from Prince Edward Island. Irish moss, a valuable commercial seaweed, is harvested off the island's coast.

Transportation and energy. Confederation Bridge and a ferryboat line carry passengers and motor vehicles across Northumberland Strait between Prince Edward Island and the Canadian mainland. A second ferryboat line operates between Souris and the Magdalen Islands, a part of Quebec in the Gulf of St. Lawrence. Sheltered bays provide good harbors at Charlottetown, Georgetown, Souris, and Summerside. Icebreakers help keep them open to shipping the year around.

Airlines provide service between Charlottetown and major cities in eastern and central Canada. A fine highway system links the province's largest urban areas. All railroad service on Prince Edward Island was discontinued in the late 1980's.

The island lacks cheap sources of power. It imports nearly all its electric power from New Brunswick through a cable under Northumberland Strait.

Communication. The province has two daily newspapers. *The Guardian* was founded in Charlottetown in 1887. *The Journal-Pioneer* was established in Summerside in 1865. Eight radio stations serve the province. Station CFCY, the first one on the island, began broadcasting from Charlottetown in 1924. Cable television systems and Internet providers serve many communities.

Production and workers by economic activities

Economic activities	Percent of GDP* produced	Employed workers: Number of people	Employed workers: Percent of total
Community, business, & personal services	25	24,100	37
Finance, insurance, & real estate	20	2,200	4
Government	13	5,600	9
Wholesale & retail trade	11	9,900	15
Manufacturing	10	6,500	10
Transportation & communication	7	5,000	8
Agriculture	5	4,600	7
Construction	5	3,800	6
Fishing & forestry	3	2,700	4
Utilities	1	100	†
Total	100	64,500	100

*GDP = gross domestic product, the total value of goods and services produced in a year.
†Less than one-half of one percent.
Figures are for 2000.
Source: Statistics Canada.

Government

Lieutenant governor of Prince Edward Island represents Queen Elizabeth II of the United Kingdom in her role as the queen of Canada. The lieutenant governor is appointed by the governor general in council of Canada. The position of lieutenant governor is essentially an honorary one.

Premier of Prince Edward Island is the actual head of the provincial government. Like the other provinces and Canada itself, Prince Edward Island has a parliamentary form of government. The premier is an elected member of the Legislative Assembly and is usually the leader of the Assembly's majority party. The premier presides over the Executive Council (cabinet). This council includes the premier and a number of ministers appointed by the premier from among his or her party's members in the Legislative Assembly. The council resigns if it loses the support of a majority of the Assembly.

Legislative Assembly is a one-house legislature that makes the provincial laws. It has 27 members, who are elected from 27 electoral districts. The members of the Legislative Assembly are elected to terms that may last

up to five years. However, the lieutenant governor, on the advice of the province's premier, may call for an election sooner.

Courts. The highest court on Prince Edward Island is the Supreme Court. The Supreme Court is made up of nine justices, including a chief justice. These justices are appointed by the governor general in council of Canada. They serve until the age of 75.

Local government. Charlottetown and Summerside, the province's only cities, and most of the towns have a mayor-council form of government. Most smaller communities are governed by community councils.

Revenue. Taxes levied by the provincial government account for more than half of its income. The most important are a general sales tax and a gasoline tax.

The rest of the province's income comes from federal-provincial tax-sharing arrangements and federal grants. License fees and governmental liquor sales are other sources of income.

Politics. Prince Edward Island has three political parties—the Liberal Party; the New Democratic Party; and the Progressive Conservative Party, usually called simply the Conservative Party. The Liberals have controlled more than half the administrations of the province.

The premiers of Prince Edward Island

	Party	Term		Party	Term
James C. Pope	Conservative	1873	**Walter M. Lea**	Liberal	1930-1931
Lemuel C. Owen	Conservative	1873-1876	**James Stewart**	Conservative	1931-1933
Louis H. Davies	Liberal	1876-1879	**W. J. P. MacMillan**	Conservative	1933-1935
William W. Sullivan	Conservative	1879-1889	**Walter M. Lea**	Liberal	1935-1936
Neil McLeod	Conservative	1889-1891	**Thane A. Campbell**	Liberal	1936-1943
Frederick Peters	Liberal	1891-1897	**J. Walter Jones**	Liberal	1943-1953
Alexander B. Warburton	Liberal	1897-1898	**Alexander W. Matheson**	Liberal	1953-1959
Donald Farquharson	Liberal	1898-1901	**Walter R. Shaw**	*Prog. Cons.	1959-1966
Arthur Peters	Liberal	1901-1908	**Alex B. Campbell**	Liberal	1966-1978
Francis L. Haszard	Liberal	1908-1911	**Bennett Campbell**	Liberal	1978-1979
Herbert J. Palmer	Liberal	1911	**J. Angus MacLean**	*Prog. Cons.	1979-1981
John A. Mathieson	Conservative	1911-1917	**James M. Lee**	*Prog. Cons.	1981-1986
Aubin E. Arsenault	Conservative	1917-1919	**Joseph Ghiz**	Liberal	1986-1993
John H. Bell	Liberal	1919-1923	**Catherine Callbeck**	Liberal	1993-1996
James Stewart	Conservative	1923-1927	**Keith Milligan**	Liberal	1996
Albert C. Saunders	Liberal	1927-1930	**Patrick G. Binns**	*Prog. Cons.	1996-

*Progressive Conservative.

History

Exploration and early history. The Indians of what is now Prince Edward Island belonged to the Micmac tribe. Vikings may have visited the island around A.D. 1000. Basque fishing crews from Europe landed there in the early 1500's. The French explorer Jacques Cartier landed on the island on June 30, 1534. Another French explorer, Samuel de Champlain, claimed the island for France in 1603. He named it *Ile St. Jean* (Isle St. John). The island became part of the French colony of Acadia.

French people began to settle on the island in 1720. British troops took over the area in 1758, during the French and Indian War (1754-1763). They deported most of the French Acadians to France. In the Treaty of Paris of 1763, France gave the island to Britain (now the United Kingdom). The British changed its name to St. John's Island and made it a part of Nova Scotia.

In 1765, the colony was divided into 67 townships. In 1767, these townships were given away in a lottery to British nobles, military officers, and government officials. The British depended on these landlords to develop the area. Few of the landlords kept their promises to improve their property, and the landownership question led to bitter political disputes. In 1769, St. John's Island became a separate British colony. The British changed its name to Prince Edward Island in 1799.

Self-government. The British gave the islanders control of their local affairs in 1851. In 1864, delegates from Prince Edward Island, New Brunswick, and Nova Scotia met in Charlottetown to discuss forming a *Maritime union* (union of these Maritime colonies). Delegates from present-day Ontario and Quebec joined them and proposed a federal union of all the provinces. The delegates met again later in 1864 in Quebec. This conference drew up a plan for Canadian union that led to the creation of the Dominion of Canada on July 1, 1867.

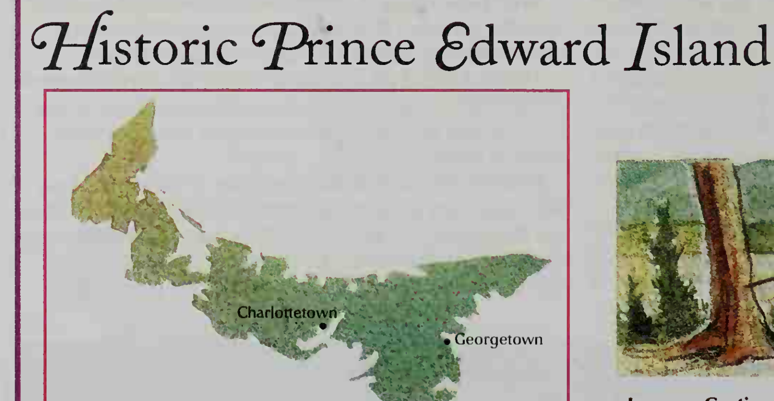
Prince Edward Island refused to join the Dominion. The people were enjoying a period of great economic prosperity and did not feel they needed union. In addition, they feared that the larger provinces would control their small island in the new government.

Member of the union. In the early 1870's, the Prince Edward Island Railway was built. As a result, the island fell into debt, and the people realized they needed help. On July 1, 1873, Prince Edward Island entered the Dominion as the seventh province. James C. Pope, a Conservative who was born on the island, became the first provincial premier in the confederation.

The problem of absentee landownership continued until the provincial government passed the Land Purchase Act of 1875. This act forced many landlords to sell their property and gave the province funds to buy the property. The people bought the land from the province and improved their own farms.

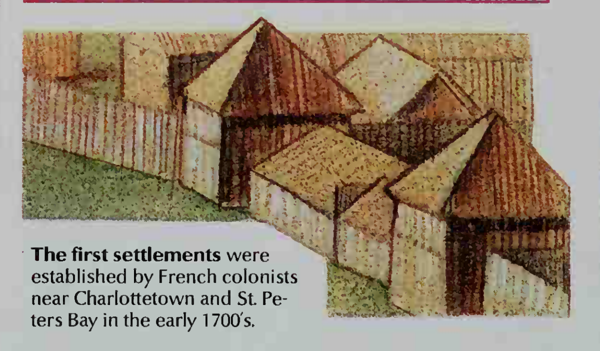
During the late 1800's, the province's small local industries could not compete with the larger industries in central Canada, and the island's economy declined.

Historic Prince Edward Island

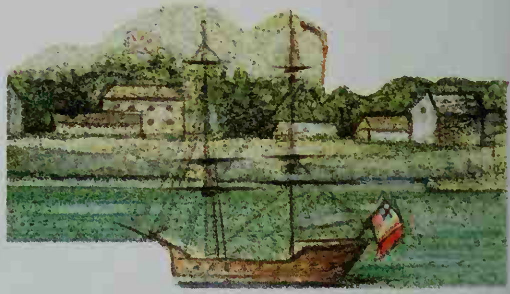




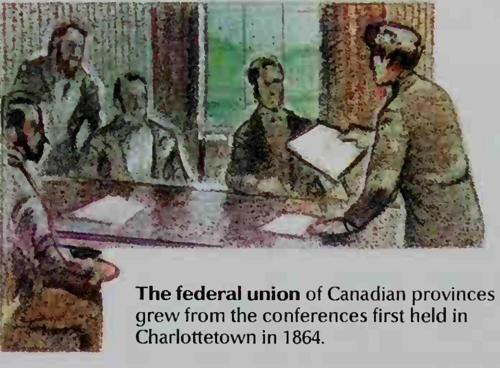
Jacques Cartier, a French explorer, landed on what is now Prince Edward Island in 1534.



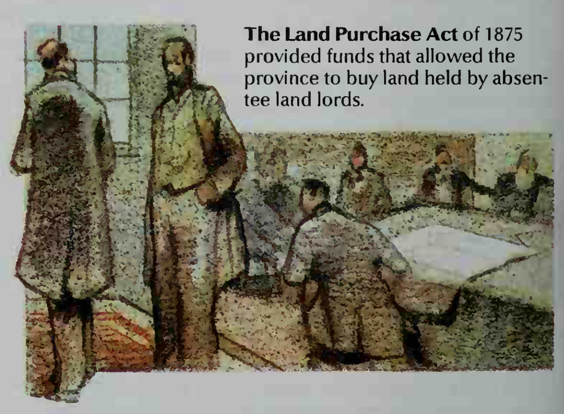
The first settlements were established by French colonists near Charlottetown and St. Peters Bay in the early 1700's.



The British obtained the island from France by the Treaty of Paris in 1763.



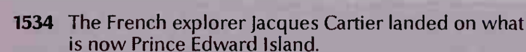
The federal union of Canadian provinces grew from the conferences first held in Charlottetown in 1864.



The Land Purchase Act of 1875 provided funds that allowed the province to buy land held by absentee land lords.

WORLD BOOK illustrations by Kevin Chadwick





Important dates in Prince Edward Island

1534 The French explorer Jacques Cartier landed on what is now Prince Edward Island.

1603 The French explorer Samuel de Champlain claimed the island for France and named it Ile St. Jean.

1720 France established settlements near present-day Charlottetown and St. Peters Bay.

1758 British troops took over the island during the French and Indian War.

1763 France ceded the island to Britain in the Treaty of Paris. Britain renamed the area St. John's Island and annexed it to Nova Scotia.

1769 The island became a separate British colony.

1799 The colony was renamed Prince Edward Island.

1851 The colony was granted self-government.

1864 The first Confederation Conference was held in Charlottetown to discuss a federal union.

1873 The island entered the Dominion of Canada on July 1.

1875 Absentee landownership on the island was ended.

1890's Thousands of islanders began moving to the mainland in search of greater job opportunities.

1984 An economic development program, which began in 1969, was completed.

1993 Catherine Callbeck became the premier of Prince Edward Island. She was the first woman in Canada to gain a provincial premiership by leading her party to victory in a general election.

1997 Confederation Bridge, which connects Prince Edward Island and the Canadian mainland, opened.

Prince Edward Island's limited income from taxes decreased as the population grew smaller, and the island became more dependent on federal aid. Thousands of islanders moved away. They sought greater job opportunities elsewhere in Canada and the United States.

During the 1920's and 1930's, the province expanded such governmental services as education, health and welfare, and public works. The high costs of these services increased the province's financial problems.

The mid-1900's. The 1941 census showed the first population increase on Prince Edward Island since 1891. During the 1940's, the province received large increases in federal aid, which helped pave many of the island's red clay roads. The improved highways in the province speeded delivery of farm and fishery products to markets, increased contact between urban and rural areas, and made school consolidation possible.

Economic development. A federally supported economic development plan, begun in 1969, was concluded in 1984. This plan provided for new schools and highways, opened new markets for farm and fish products, and expanded the tourism industry. It also helped attract some small manufacturing companies to the province. But manufacturing remains limited. The province continues to rely on the service industries—especially tourism—and on agricultural production. The island is also still heavily dependent on federal economic aid. Prince Edward Island has one of the lowest provincial and *per capita* (per person) incomes in all of Canada. But the island's residents are working to create a stable economy that will enable people in both rural districts and small communities to make a comfortable living.

Recent developments. In 1993, construction began on a bridge to connect Prince Edward Island and New Brunswick across Northumberland Strait. The bridge, called Confederation Bridge, was completed in 1997.

In January 1993, the Liberal Party chose Catherine Callbeck to succeed Joseph Ghiz as party leader and premier of Prince Edward Island. The Liberals won the general election held in March, making Callbeck the first woman in Canadian history to become a provincial premier by leading her party to victory in a general election. Callbeck resigned as party leader and premier in 1996. Keith Milligan succeeded her in both positions. The Progressive Conservatives won a general election in November. Patrick G. Binns, the Conservative leader, then became premier. Harry Baglole and David Weale

Study aids

Related articles in *World Book* include:

Acadia
Atlantic Provinces
Borden
Charlottetown
Gulf of Saint Lawrence
Harris, Robert
Montgomery, Lucy Maud

Outline

I. People
A. Population
B. Schools
C. Libraries and museums
II. Visitor's guide
A. Places to visit
B. Annual events
III. Land and climate
IV. Economy
A. Natural resources
B. Service industries
C. Agriculture
D. Manufacturing
E. Fishing industry
F. Transportation and energy
G. Communication
V. Government
A. Lieutenant governor
B. Premier
C. Legislative Assembly
D. Courts
E. Local government
F. Revenue
G. Politics
VI. History

Questions

How does Prince Edward Island rank among the provinces in size? In population density?
Why has the province's manufacturing developed slowly?
How does the island obtain electric power?
What was the Land Purchase Act of 1875?
How is the island nearly cut into three parts?
What is the province's chief crop?
What are Prince Edward Island's only two cities?
Why did Prince Edward Island refuse at first to join the Dominion of Canada?
What are the province's nicknames? To what do they refer?
Who was the first European explorer to land on what is now Prince Edward Island?

Additional resources

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Campbell, Kumari. *Prince Edward Island.* Lerner, 1996.
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Prince George (pop. 72,406) is an industrial city in the Canadian province of British Columbia. The city lies near



© Canfor Corporation

Prince George, an industrial city in British Columbia, is a center for pulp and paper manufacturing. Pulp mills such as the one shown above have stimulated the city's growth.

the center of British Columbia, at the junction of the Fraser and Nechako rivers (see **British Columbia** [political map]). The leading industries in the city manufacture chemicals, lumber products, petroleum products, and pulp and paper. Mines in the area produce coal, copper, mercury, and molybdenum. Prince George is the home of the University of Northern British Columbia.

Carrier Indians lived in the Prince George area before whites arrived in the early 1800's. Simon Fraser, who worked for the North West Company, a fur-trading firm, founded a trading post there in 1807. He named it Fort George after King George III of the United Kingdom.

Fort George grew quickly after the Grand Trunk Pacific Railway began to serve the area in 1914. It was renamed Prince George and incorporated in 1915. Prince George grew rapidly during the 1960's, when three pulp mills opened in the area. Prince George has a mayor-council form of government. Roy K. Nagel

For the monthly weather in Prince George, see **British Columbia** (Climate).

Prince of Wales is the title given to the first male heir to the British throne. He is always the oldest son of the sovereign, unless that son has died or given up the title. Edward I, the English king who conquered Wales in 1282 and 1283, defeated and killed the last Welsh Prince of Wales. In 1301, he gave the title to his oldest son. Later, this son became king as Edward II. Since the reign of Edward II, almost all the oldest male heirs to the British throne have received it.

The title *Prince of Wales* is purely honorary. Sons of British monarchs do not inherit the title. It is newly created for each prince. The monarch's oldest son becomes *Duke of Cornwall.* Even after he is named Prince of Wales, he receives his income from the Duchy of Cornwall, not from Wales. Queen Elizabeth II's son, Prince Charles, became Duke of Cornwall when his mother took the throne in 1952. His mother named him Prince of Wales in 1958 and officially presented him to the Welsh people in 1969. Ralph A. Griffiths

See also **Charles, Prince.**

Prince Rupert, British Columbia (pop. 14,643), is the second largest port on Canada's west coast. Only Vancouver is larger. The city lies on Kaien Island, north of the mouth of the Skeena River. For location, see **British Columbia** (political map). A bridge links the city to the mainland. Prince Rupert is a fishing, logging, and pulp-producing center. The city has the world's largest salmon cannery. It also has the world's largest cleaning grain elevator, a facility that removes foreign material from grain before storing it. A coal terminal opened in Prince Rupert in 1984. The city has a mayor-council form of government. Daniel Gilmore

Princess. See Prince.

Princeton, Battle of. See **Revolutionary War in America** (Trenton and Princeton; table; map).

Princeton University is a coeducational private university in Princeton, New Jersey. It is the fourth oldest institution of higher learning in the United States. Only Harvard, William and Mary, and Yale are older. Princeton provides undergraduate and graduate instruction primarily in architecture, engineering, liberal arts, and sciences.

Princeton graduates and faculty members have played an important role in United States political history. Richard Stockton, a member of the first Princeton graduating class, and John Witherspoon, an early president of the university, were signers of the Declaration of Independence. One-sixth of the members of the Constitu-



© Mike Grandmaison

Prince Rupert, in British Columbia, is the second largest port on Canada's west coast. Only Vancouver is larger. Prince Rupert lies on Kaien Island, north of the mouth of the Skeena River. Boating is a popular pastime among the city's residents.



Mahlon Lovett, Princeton University

Princeton University, founded in 1746, is one of the oldest institutions of higher learning in the United States. The courtyard outside McCosh Hall, *shown here,* is a popular meeting place.

tional Convention studied at Princeton. Presidents James Madison and Woodrow Wilson graduated from Princeton. Wilson also headed Princeton from 1902 to 1910. Vice Presidents Aaron Burr and George M. Dallas and several Cabinet members and justices of the Supreme Court of the United States were also graduates.

Campus buildings. The campus includes over 150 buildings, not counting residences for faculty and staff. Nassau Hall, completed in 1756, is the oldest building. It was occupied by British and colonial forces during the Revolutionary War in America. General George Washington captured the building on Jan. 3, 1777, to end the Battle of Princeton, a turning point in the war. Nassau Hall was the national capitol for four months in 1783, when the Congress of the Confederation met there.

The university library includes many specialized libraries and has collections that range from Egyptian papyri and Babylonian cylinder seals to the papers of American author F. Scott Fitzgerald. The Plasma Physics Laboratory is on the James Forrestal campus, about 3 miles (5 kilometers) from the main campus. Other laboratories there include the Geophysical Fluid Dynamics Laboratory and the Daniel and Florence Guggenheim Laboratories for the Aerospace Propulsion Sciences.

Educational program. Princeton has 33 departments and 23 interdepartmental programs. The undergraduate plan of study includes the preceptorial method, which brings teacher and student together and fosters individualism. The four-course plan of study encourages self-education. Students acquire broad knowledge in their underclass years. In their upperclass years, they engage in a specific field or interdepartmental program. The graduate school offers courses in architecture, engineering and applied science, liberal arts and sciences, and international affairs. The Woodrow Wilson School prepares students for careers in public service.

History. Princeton University was founded in 1746 as a college for men called the College of New Jersey. It was originally sponsored by the Presbyterian Church, but it was one of the first colleges in the United States to admit students of all faiths. The first classes were held in 1747 in Elizabeth, New Jersey. The college moved to Newark in 1748, and to Princeton in 1756. It was renamed Princeton University in 1896. In 1969, Princeton became coeducational.

During the 1960's and 1970's, the university built an architecture hall, a computer center, a manuscript library, a center for music, and dormitories. The Tokamak Fusion Test Reactor at the Plasma Physics Laboratory opened in 1982 and operated until 1997. A new fusion device called the National Spherical Torus Experiment opened in 1999. Critically reviewed by Princeton University

See also **Wilson, Woodrow** (University president); **Witherspoon, John; New Jersey** (picture: Princeton University).

Principal, in economics. See **Interest** (Types of interest); **Mortgage.**

Príncipe Island. See **São Tomé and Príncipe.**

Print. See **Engraving; Japanese print; Percale; Photography** (Developing and printing); **Printing.**

Printer is a device used to print text and illustrations created using a computer. There are three main types of printers: (1) laser printers, (2) inkjet printers, and (3) impact printers. Each type of printer responds to instructions from software in the computer.

Laser printers use a process adapted from photocopying machines. A tiny, precise laser electrically charges portions of a light-sensitive metal drum, duplicating on its surface the text or images created on the computer. Dry ink called *toner* is oppositely charged and dusted onto the drum. The toner sticks only to the charged parts of the drum. Paper is given an electrical charge matching that on the charged portions of the drum but stronger. The paper is then pressed against the drum, and the toner is attracted to the paper. The paper passes through rollers that heat it for an instant, causing the toner to adhere permanently to the paper.

Laser printers can produce several pages of text per minute. They reproduce complex images and photographs more slowly. Some can produce color output. Some laser printers also can approach the print quality standards of traditional printing presses. Laser printers have revolutionized the printing and design industries and made possible *desktop publishing* (the use of personal computers to design and edit publications). See **Computer** (picture: Parts of a laser printer)

Inkjet printers use a high-speed nozzle to spray a jet of ink onto paper in a pattern that matches the text or images created on the computer. See **Inkjet printer.**

Impact printers include *dot-matrix printers* and *daisy-wheel printers.* Dot-matrix printers use tiny pins to strike an inked ribbon, thus transferring ink to paper. Computer software controls the sequence in which the pins strike the ribbon to form letters, numbers, and images. Daisy-wheel printers use a wheel with letters and other characters on it. Software directs the wheel to rotate to the correct position. A hammer hits the positioned character's "spoke," which in turn strikes a ribbon, transferring ink to the paper.

Impact printers are among the earliest types of printers, and they are rarely used today. They are still employed, however, in situations that require impact, such as printing on multiple-sheet forms. Keith Ferrell

See also **Ink** (Printing inks).



© Dale Debolt

A wide variety of printed items—from books, maps, and newspapers to bottles, cans, and articles of clothing—rolls off the presses each day in nearly every part of the world.

Printing

Printing is one of our most important means of mass communication. It is the process by which words and images are reproduced on paper and on such other materials as metal, glass, and fabrics. Printing provides books, tests, and many other study materials for our educational system. Business depends on printing for a wide variety of items, including stationery, order forms, and shipping labels. Printed advertising, from magazine and newspaper advertisements to coupons and billboards, is a popular way to sell goods and services.

Printing is a major industry in many countries. In addition to books, newspapers, magazines, and catalogs, thousands of other items are printed every day. These items include candy bar wrappers, calendars, ruled writing tablets, T-shirts, post cards, playing cards, and reproductions of works of art. Special machines can even print directly on cans or on glass or plastic bottles.

Many people confuse the printing industry with the publishing industry. Publishing is the process of assembling written information and *graphics* (illustrations), and coordinating the production, distribution, and sale of the resulting product. Some publishers own their own printing equipment and do the actual printing of their products, as most daily newspapers do. Most publishers, however, do not own printing equipment. Instead, they contract with a commercial printer to have their books, magazines, or papers printed.

Printing as we know it began in Europe less than 600 years ago. Printing with movable type had existed in East Asia since at least the 700's, but the invention had not spread to Europe. Everything people read had to be copied by hand or printed from wood blocks carved by hand. Then about 1440, the German goldsmith Johannes Gutenberg and his associates developed movable type. Gutenberg made separate pieces of metal type for each character to be printed. With movable type, a printer could quickly make many copies of a book. The same pieces of type could be used again and again, to print many different books.

Printing soon became the first means of mass communication. It put more knowledge in the hands of more people faster and more affordably than ever before. As a result, reading and writing spread widely and rapidly.

This article discusses the preparation of type and illustrations for printing and describes the major commercial printing processes. It also discusses several other printing processes and traces the history of printing. Separate *World Book* articles, such as **Bookbinding** and **Photocomposition**, provide details on various steps in the printing process. Other articles, including **Engrav-**

The contributor of this article is Frank J. Romano, Professor in the School of Printing at Rochester Institute of Technology.

ing, Etching, Intaglio, and Screen printing, give information on printmaking in the fine arts.

Preparing material for printing

All printing processes follow certain basic steps in preparing text and illustrations for printing. These steps include (1) typesetting, (2) preparing illustrations for reproduction, and (3) page makeup.

Typesetting is the assembly of individual letters and numbers to create the text portion of the printed piece. In the past, skilled workers called *compositors* took individual pieces of carved and cast metal type and manually arranged them, letter by letter, to form lines and pages of text. Mistakes were common, and a sample copy of a complete page, called a *proof,* was checked for errors before proceeding with other steps in the printing process. This checking of sample pages became known as *proofing* or *proofreading,* and it is still a major part of the printing process. See Proofreading.

Three important typesetting processes are (1) electronic imagesetting, (2) hot-metal typesetting, and (3) phototypesetting. Electronic imagesetting is the main typesetting process used today. It can produce both text and graphics. Hot-metal typesetting and phototypesetting produce text only.

Electronic imagesetting uses computers and computer printers to produce many kinds of printed materials, including catalogs, advertisements, and legal documents. Programs for these computers enable users to perform such tasks as word processing, type selection, reproduction of graphics, and *page makeup,* which involves the positioning of both text and graphics on a page. Some programs enable users to stretch letters, condense them, and change them in a number of other ways. A type face, also called a *font,* can be viewed on the computer screen and changed with the push of a key or the click of a button. The computer can also *justify* the text—that is, it can adjust the spacing between words so that all full lines are the same length.

After a page has been designed and the text typed in, the information is converted to a *digital* (numeric) file. A digital file can be used in several ways. It can be transmitted to a desktop printer to produce a proof. The use of desktop machines to typeset and print newsletters, books, newspapers, and magazines is often called *desktop publishing.* A digital file can also be stored on a computer disk for later use. Or it can be sent through a computer network via a device called a *modem.* In a process called *photocomposition,* digital files may be output directly to *laser platesetters.* These machines produce printing *plates,* flat pieces of metal or plastic bearing an image of the material to be printed. Or the digital file can be sent to a *photoimagesetter,* a machine that creates light-sensitive paper or film of complete pages of text and graphics. The paper or film is then used to produce printing plates. See Photocomposition.

Hot-metal typesetting was the dominant form of typesetting from the late 1800's until the mid-1900's. It is still used today for limited printing of greeting cards, diplomas, and specialty items. The process uses molten metal and molds of letters, numbers, and other characters to produce type. A worker sits at a keyboard on a typesetting machine and enters the text to be typeset. The machine retrieves the necessary molds and spaces and arranges them according to the commands.

There are two kinds of hot-metal typesetting machines, the *Monotype* and the *linecaster.* The Monotype molds type character by character. When the typesetter strikes keys on the keyboard, a series of holes are punched into a paper tape. The holes form a code that tells the machine which characters of type are required. A linecaster places a character mold in position for each key struck. When a line is completed, the machine uses hot metal to cast the entire line at once. The most popular type of linecaster is the Linotype.

Phototypesetting produces images of letters and other characters on light-sensitive film or paper. It is also called *cold-type composition.* Phototypesetting was the dominant typesetting process from the 1950's to the 1980's, but it is rarely used today.

Preparing illustrations for reproduction. Printers deal with two main types of graphics, *line reproductions* and *halftone reproductions.* Most printing operations use electronic *scanners,* which record an image with light sensors, or digital cameras to produce digital files of both kinds of graphics. But photographic techniques can also be used to generate either type of image.

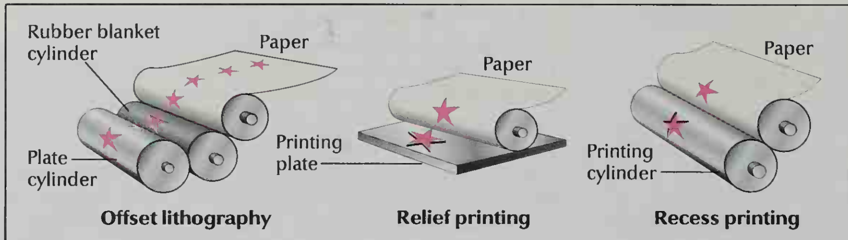
Line reproductions are used for *line art*—illustrations that consist of solid areas or solid lines. Such graphics include pen-and-ink drawings, maps, diagrams, and other illustrations without color or shading.

Halftone reproductions are required when the illustrations have a range of tones or shades from dark to light. Such material, called *continuous-tone copy,* includes paintings and photographs. A printing press can print only solid colors, not continuous tones. The illusion of shading, however, can be created by printing a pattern of tiny dots. To the viewer's eye, the dots blend and seem to duplicate the shading of the original art.

Most halftones are produced electronically. First, illustrations are converted to digital code. This may be done by photographing subjects with a digital camera, or by converting prints or slides to digital images using a scanner. A computer is used to determine the organization of the dots for the halftones. In a technique called *AM screening,* the centers of the dots are equally spaced, but the dots vary in size. In *FM screening,* the dots are all the same size, but the spacing between them varies. To learn how color illustrations are printed, see the *Printing in color* section of this article.

Some reproductions are created photographically. Special cameras expose high-contrast film, producing images of the exact size needed for the printed reproduction. For line copy, a simple negative is made. Halftone images can be produced photographically by shooting an illustration through a piece of film called a *halftone screen.* This screen is mounted between the camera lens and the photographic film. It carries a pattern of transparent squares on a black background. As in AM screening, the squares are equally spaced but vary in size. Light reflected from the copy passes through the squares and forms an image on the negative.

Page makeup, also called *image assembly,* involves arranging type and illustrations to form pages. Pages can be assembled by hand, but most designers use computers. Special computer programs enable designers to integrate digital files of text and graphics to assemble pages. On a computer monitor, a designer can



WORLD BOOK illustrations by Paul Perrault

Common printing methods include offset lithography, relief printing, and recess printing. Offset lithography is done from an even surface; relief printing, from a raised surface; and recess printing, from a sunken surface.

see exactly where the text and graphics—represented by boxes called *windows* or *frames*—will appear on a page. The designer can quickly adjust the positions of the windows. When the page is printed, the text and graphics appear where the designer positioned the windows. The page can be printed using a computer printer. The pages can also be output directly to a printing plate, or the image can be transferred onto light-sensitive paper or film that will then be transferred to a printing plate. For certain applications, the output is produced with the graphics windows taking the place of the illustrations.

Platemaking. Once the individual pages are made up, they are *imposed*—that is, put into position for the printing plate. They can be imposed directly from a computer to a printing plate or to paper or film, or the pages can be positioned by hand.

When laying pages out by hand, a specialist called a *stripper* positions film negatives of pages onto a sheet of plastic or special paper in a process called *stripping*. The stripper places dark boxes or cuts out windows where line and halftone negatives will be inserted. If the pages have been laid out on a computer and transferred onto paper or film, the graphics are usually already in position. When everything is in place, the stripper cuts away the paper or plastic from the image areas, allowing the image to transfer onto a light-sensitive printing plate. The plate picks up these images for reproduction on the printing press.

Methods of printing

Most commercial printing today is done by one of four processes: (1) offset lithography, a type of planographic printing; (2) relief printing; (3) recess printing, also called gravure printing; (4) and digital printing. Each of these processes uses a different kind of printing surface to carry the images to be printed. In offset lithography, the most widely used process, the printing surface and the nonprinting surface are on the same level. In relief printing, which includes *letterpress* and *flexographic* processes, the printing surface is raised. In recess printing, which includes engraved printing, the printing surface is below the nonprinting surface. Digital printing uses an electrically charged drum and a dry or liquid ink called *toner,* or *inkjets* that drop or spray ink on the printing surface without even touching it.

Printing presses print on sheets or rolls of material called a *substrate*. Usually the substrate is paper, but other common substrates include plastics, foils, and cardboard for packaging. Presses that print on sheets are called *sheet-fed presses*. Those that print on rolls are called *web-fed presses* or *web presses*. A roll of substrate is called a *web*.

Offset lithography is based on the fact that grease and water do not mix. The process is also more simply called *offset* or *lithography*. Alois Senefelder, a German printer, discovered the principle of lithography in 1798. He drew a design on a smooth, flat stone with greasy crayon. Then he dampened the stone, and the water stuck only to the parts not covered by the design. Next, he inked the stone, and the ink stuck only to the design. He then pressed paper against the stone and transferred the image to the paper.

In offset lithography, thin metal plates have replaced Senefelder's stone, and the images are put on the plates photographically, or electronically using a laser. The inked images do not print directly on the paper that is fed through the press. Instead, the images are *offset* (transferred) to a rubber-covered cylinder, called a *blanket cylinder,* which in turn offsets them to the paper or other substrate.

Almost anything can be printed by offset lithography. The process is used for such items as books, cards, magazines, stationery, cans, cartons, business forms, labels, and newspapers. Nearly half of all printing today is done by offset lithography.

Offset printing plates may be either *negative-working* or *positive-working*. Negative-working plates are made photographically from negatives assembled during page makeup. The negatives are held by vacuum pressure against a metal plate with a coating that hardens when exposed to light. Powerful lamps shine light through the transparent parts of the negatives, hardening the image areas on the plate. The plate is treated with a solution of developer and lacquer. The lacquer adheres only to the image areas. The plate is washed, and a gum is applied to thoroughly cleanse the nonimage areas so they will reject any ink. During printing, only the lacquered areas accept ink. Positive-working plates require film positives or specially treated paper. They are made by photographing negatives or by printing the negatives on film or paper.

Some offset plates can receive images directly in an imagesetting or platesetting device, eliminating the use of paper or film. This process is referred to as *computer-to-plate* or *direct-to-plate*. Images are transferred as a digital code. This code is then read by a laser platesetter, which then produces the printing plates.

Offset presses are *rotary* presses—that is, they use revolving cylinders to hold both the printing plate and the substrate. An offset press prints from a curved printing plate clamped to a rotating *plate cylinder*. As the cylinder rotates, it presses against dampening rollers, which wet the plate so the nonprinting areas will repel ink. The cylinder next passes against inking rollers, and ink sticks

only to the image areas. The turning plate cylinder then offsets the inked images onto a rotating *blanket cylinder,* a cylinder covered with a rubber blanket. The blanket cylinder offsets the images onto the paper or other substrate carried by an *impression cylinder.* This assembly of rollers and cylinders is known as a *printing unit.*

In a sheet-fed offset press, sheets of paper pass through the printing unit one at a time. Sheet-fed presses have one, two, four, or more units. In presses with multiple printing units, each unit prints a different color. Some sheet-fed presses are *perfecting presses*—that is, they print both sides of the paper in a single pass.

After a worker sets up the press, sample copies are printed. Then, in a process called *makeready,* the printer makes adjustments to get the best impression. If more than one color is being printed, the *register* (alignment) of the colors is adjusted during makeready.

Most web-fed offset presses are multicolor perfecting, blanket-to-blanket presses. These presses do not use impression cylinders. The web of paper passes between the blanket cylinders of two units. The blanket cylinder of each unit serves as the impression cylinder for the other. The paper is printed on both sides as it passes between the blankets.

Next, the paper is gathered onto another roll, or it is cut and folded into groups of pages called *signatures.* Some presses are fitted with high-speed staplers, called *stitchers,* that produce finished, stapled magazines. Other presses have gluers and cutters that create envelopes or three-dimensional printed pieces, such as stand-up displays or pop-up greeting cards.

Offset presses are fast. Sheet-fed presses can print up to 250 sheets per minute. Some web presses can run at speeds of 3,000 feet (900 meters) per minute.

Relief printing is the oldest printing method. More than 1,300 years ago, people in East Asia printed from wood blocks. They carved the nonprinting areas from the surface of a piece of wood, leaving characters and designs *in relief* (raised). They inked the raised surface, placed a sheet of paper on the block, and transferred the ink to the paper by rubbing the back of the sheet.

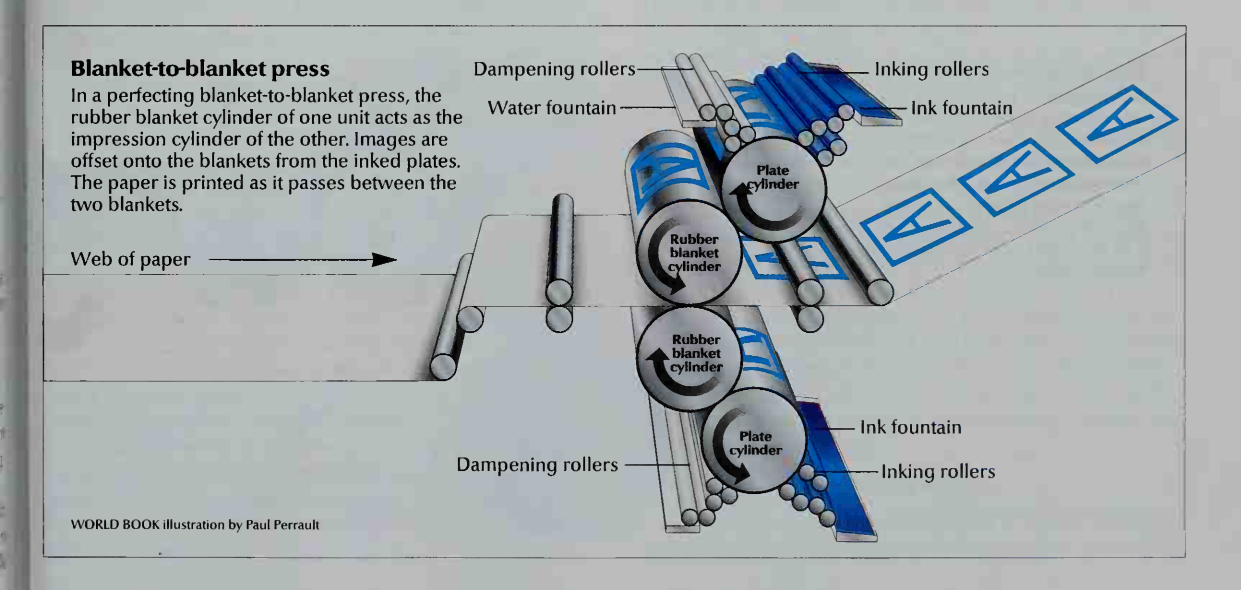
There are two common forms of relief printing used today, flexographic printing and letterpress printing.

Flexographic printing. Flexographic plates are made of rubber or soft plastic. Their softness makes them especially useful for printing on materials that should not be squeezed too hard, such as corrugated paper, foils, and plastics. Almost anything that can go through a web press can be printed flexographically. Such items include newspapers, cardboard cartons, and gift wrap.

Flexographic plates can be made photographically or by laser. In the photographic method, a metal or plastic sheet is exposed to ultraviolet or other special light through a negative. The sheet is chemically treated so that the part exposed to light hardens. The nonimage areas remain soft and can be washed away, thereby creating a plate with raised image areas. This plate is pressed into cardboard or soft plastic, leaving a negative relief of the image. The negative relief is then used as a mold or *mat.* A sheet of rubber or plastic is pressed into the mold under heat and pressure, forming a positive relief plate. The other method for making flexographic plates uses a laser to cut an image from a specially treated rubber plate or cylinder.

Flexographic presses use a single roller to apply ink to the printing plate. A *doctor blade* scrapes excess ink from the roller, which rotates inside an ink fountain. Flexographic presses squeeze the paper or other substrate between an impression cylinder and a plate cylinder. The impression pressure is adjusted to the minimum needed to get a clear reproduction. This light impression is called a *kiss impression.*

Letterpress printing. A letterpress printing press uses plastic or metal relief printing plates or *type forms.* A type form consists of type and other material locked in a metal frame for printing. Letterpress dominated printing from its invention in the mid-1400's until the mid-1900's. Letterpress declined in popularity largely because its text and halftone image quality is not as good as that produced by offset. In addition, letterpress makeready tends to take a long time and waste much paper. Today, the letterpress process is used only by specialty print-



Blanket-to-blanket press

In a perfecting blanket-to-blanket press, the rubber blanket cylinder of one unit acts as the impression cylinder of the other. Images are offset onto the blankets from the inked plates. The paper is printed as it passes between the two blankets.

WORLD BOOK illustration by Paul Perrault

ers. Most items that were once printed by letterpress are printed by offset today. Others, including some newspapers, are produced by flexography.

Letterpress printing plates are made photographically, in a process similar to that used for flexographic plates. The plastic or metal plates are chemically treated so that the surface hardens in image areas that are exposed to light. The nonimage areas remain soft and can be removed with water, a chemical solution, or a blast of air. Removing these areas leaves the image in relief. The plate is then hardened further before printing.

Letterpress printing presses include *platen, flat-bed,* and rotary presses. Platen presses have two main parts. A *bed* holds the type form or printing plate, and a metal plate called a *platen* holds the paper to be printed. The two parts are both flat, and they are joined together like a clamshell. Rollers ink the form or plate as a sheet of paper is fed to the platen. The platen then swings against the printing surface and prints the sheet as the rollers roll back to get more ink from an inking plate. As the platen swings back, the printed sheet is released.

Flat-bed presses move the type form, which rests on the flat bed of the press, against a rotating impression cylinder. The paper, which is attached to the cylinder, is printed as it rolls over the form.

Rotary presses for letterpress printing are similar to those used in flexographic printing. Rotary presses are used today for specialty letterpress printing.

Recess printing, also called *gravure printing,* is an *intaglio* (pronounced *ihn TAL yoh)* method of printing. The words, pictures, or designs to be printed are sunk into a printing cylinder or plate. Gravure is used to print a wide variety of items. They include the magazine sections of newspapers, catalogs, postage stamps, stock certificates, floor tiles, wallpaper, boxes, and gift wrap.

Gravure cylinders. Most commercial recess printing processes use printing cylinders rather than plates. This process is also called *rotogravure.* Most gravure cylinders are made by *electromechanical engraving.* In this process, an electronic scanner scans the original copy or offset film. The scanner sends signals to a computer, which directs a machine equipped with diamond-pointed cutting tools called *styluses.* The styluses cut thousands of little pits called *cells* into the copper covering of the cylinder. The cells vary in area and depth. On the printing press, the deepest cells hold the most ink and print the darkest tones. The shallowest cells hold the least ink and print the lightest tones.

Another method of gravure involves putting images on the printing cylinder photographically. The copy to be printed is photographed and made into film positives. The halftone method is not used. The positives are then assembled as they are to appear in print. Next, the images on the positives are transferred to the printing surface through the use of *carbon tissue,* a sheet of paper covered with light-sensitive gelatin. The carbon tissue is first exposed under bright light to a screen called a *gravure screen* to create a grid of light-hardened lines and softer squares on the tissue. Then the carbon tissue is exposed to the film positives. The gelatin hardens further according to how much light passes through the positives. The gelatin becomes hardest and thickest where the most light passes through.

The exposed tissue is placed gelatin side down on a heavy copper-plated cylinder. The tissue is developed in water, and the paper backing is stripped off. A layer of gelatin made up of tiny squares of varying thickness is left standing on the copper. The cylinder is then bathed in a corrosive solution. The solution eats through the gelatin squares and bites small cells into the copper. It quickly penetrates the thin squares and bites deepest into the cylinder in these areas, which thus print darkest. This process is known as *etching.*

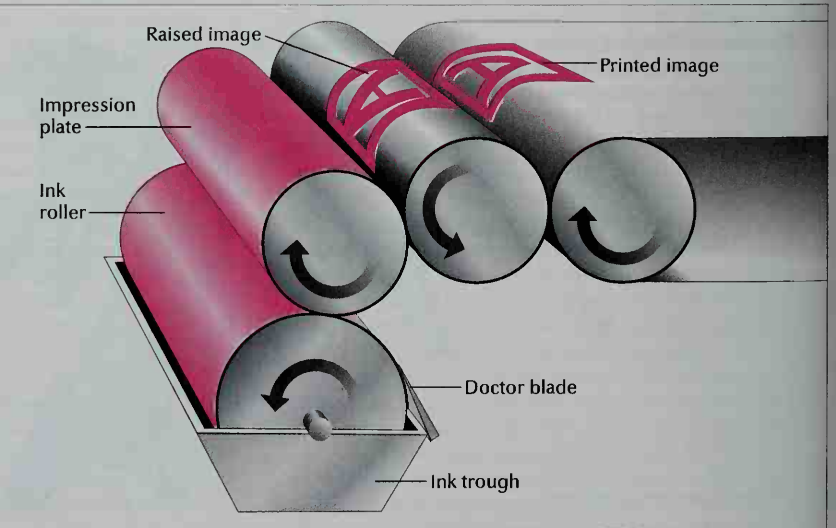
The *direct transfer* method of gravure does not use carbon tissue. Instead, a light-sensitive coating is applied directly to the cylinder and exposed to light through a halftone positive film.

Modern methods use a computer to control a laser that engraves the image directly onto the cylinder. The computer issues its instructions using information from digital files of text and graphics.

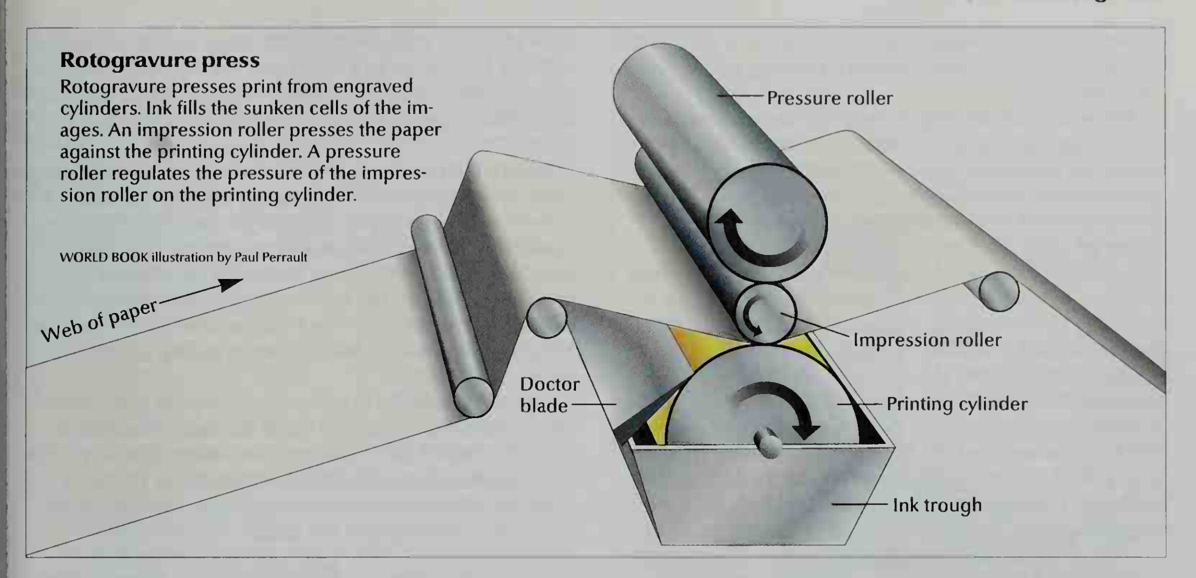
Gravure presses are usually web-fed rotary presses.

Flexographic press

A flexographic press uses a flexible printing plate wrapped around a cylinder. Ink is transferred from an ink roller to an impression cylinder. The raised image on the plate picks up ink from this cylinder and transfers it to the paper or other surface being printed.



WORLD BOOK illustration by Paul Perrault



Rotogravure press

Rotogravure presses print from engraved cylinders. Ink fills the sunken cells of the images. An impression roller presses the paper against the printing cylinder. A pressure roller regulates the pressure of the impression roller on the printing cylinder.

WORLD BOOK illustration by Paul Perrault

Rotogravure presses can run at speeds of more than 3,000 feet (900 meters) per minute. In most gravure presses, the printing cylinder rotates with its bottom edge in a trough of ink. As the cylinder turns, the cells fill with ink. A doctor blade wipes the surface clean so that the ink remains only in the cells. An impression roller presses paper against the printing cylinder and into the cells. The pressure transfers the ink in each cell to the paper. This transfer is assisted by the addition of an electrical device that creates a negative electric charge in the gravure cylinder and a positive charge on the impression cylinder. Opposite charges attract, and those on a gravure press make the ink inside the cells jump to the paper as it passes by.

Digital printing, also called *electronic printing,* is done with desktop printers or copying machines. A desktop printer requires a stream of digital data, and a copier requires an original document.

A *laser printer* is used with a computer and digital files of text and graphics. It uses a laser to give a negative electric charge to a cylinder in a pattern that corresponds to the text and graphics to be printed. Positively charged toner is attracted to the negatively charged areas. A piece of paper is pressed onto the cylinder, where it receives the toner. The paper is then passed through heated *fuser rollers,* which cause the toner particles to adhere to the paper.

Copying machines are used to duplicate printed documents. In most copiers, the original copy is scanned and converted to a pattern of dots. A laser transfers this pattern to a drum as electric charges. The copier then uses toner, paper, and fuser rollers just as a laser printer does. Some older copiers use reflected light from a special bulb to focus the copy through a lens onto a negatively charged drum. The image forms on the drum as a pattern of positively charged particles.

Some printers and copiers use inkjet technology. An inkjet squeezes small drops of ink onto a slowly moving sheet of paper to produce an image. Or it uses an array of nozzles to eject the ink continuously on a fast-moving web of paper.

Digital printing requires a new image to be created on the drum for each copy. Thus the process is capable of producing personalized direct mail, *on-demand* (one at a time) publications, and other customized printed products. All other printing methods are better suited for print runs of over 500 copies.

Other printing processes include screen printing and collotype printing.

Screen printing requires a stencil and a fine cloth or screen. The stencil carries the design to be printed. Ink is squeezed onto the printing surface through the areas of the screen not covered by the stencil. The stencil can be cut from paper. Or it can be made by tracing a design directly on the screen and blocking out the nonprinting areas with glue or lacquer. A stencil can also be made by giving the screen a light-sensitive coating and putting the design on it photographically or by laser.

The screen printing process can be used to print on paper, glass, cloth, wood, or almost any other material. It can print on objects of various sizes and shapes, including draperies, bottles, toys, and furniture. Screen printing can be done using automatic or hand-operated presses. Screen printing is also called *silk-screen printing* or *serigraphy.*

Collotype printing is similar to lithography. A metal or glass plate is coated with a light-sensitive gelatin. The gelatin is exposed to light under an unscreened negative that carries the image to be printed, and the gelatin hardens to varying degrees. The plate is then soaked in a solution of water and glycerin. The hardest parts of the gelatin absorb the least solution, and the softest parts absorb the most. On the printing press, the hardest, driest parts accept the most ink and print the darkest tones. The softest, wettest parts accept the least ink and print the lightest tones. Collotype is sometimes used to print post cards, greeting cards, posters, and high-quality reproductions of paintings.

Printing in color

Lithography, relief printing, recess printing, and digital printing can reproduce anything in color—from com-

ic strips to masterworks of art. There are two chief kinds of color printing: (1) process color printing and (2) flat color printing.

Process color printing is used mainly to reproduce color copy that contains shades or tones. Such copy includes oil paintings, water-color paintings, and color photographs. Process color printing uses tiny dots of transparent ink in the colors yellow; *magenta* (pronounced *muh JEHN tuh),* a purplish-red; *cyan* (pronounced *SY an),* a blue; and black. With only these four colors of ink, process color printing can reproduce almost any color and tone. Sometimes, colors other than these are used to achieve special effects.

Most printing operations use an electronic scanner to separate the colors in the copy. A scanner produces digital files that represent the yellow, magenta, cyan, and black components of the copy. If a halftone dot pattern is required, a scanner can generate such a pattern for each color. In printing, some of the tiny dots fall close together, some overlap, and some fall on top of others. To the viewer's eye, the colors of the dots appear to be all the colors and shades of the original copy. For example, what the eye sees as green is an area of tiny cyan and yellow dots. The digital files produced by the scanner can be stored, and they can later be output to digital printers, imagesetters, or platesetters.

In color lithography, relief printing, and recess printing, after the separations have been made, the steps follow the standard procedures for making printing plates or cylinders. On a four-color press, there are four plates. Each plate has its own supply of either yellow, magenta, cyan, or black ink. On a four-color rotary press, paper passes from one set of cylinders to the next, picking up the different colors and emerging from the press fully printed.

Before the development of scanning technology, the color components were separated photographically. A camera was used to photograph the copy four times to create a *separation negative* of the yellow, magenta, cyan, and black in the copy. Each time, a different colored filter was used to block out all colors from a negative except the desired one. Printers used the separation negatives to produce relief or offset plates, or gravure plates or cylinders.

Flat color printing is used chiefly to print *line copy* in solid colors. Such copy includes diagrams, headlines and other type matter, and trademarks on stationery. Flat color printing is simpler than process color printing. Separate plates are made for each color of opaque ink. Halftone screenings are not used.

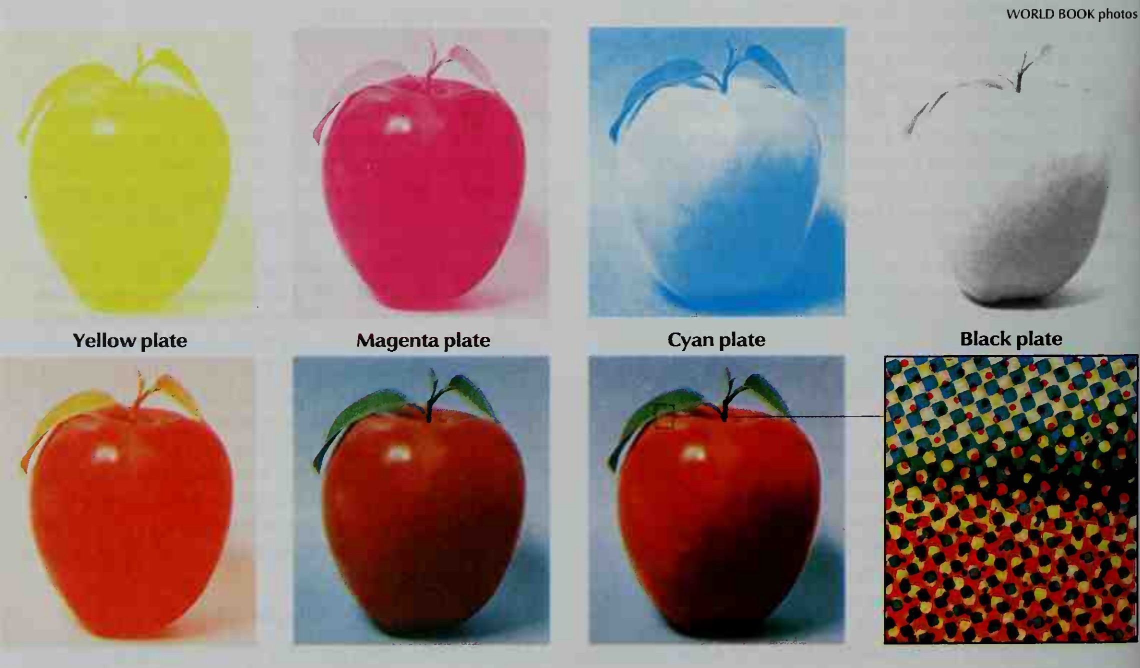
History

The history of printing can be traced back thousands of years, to when people in the Middle East learned to press carved designs into wet clay. More than 2,000 years ago, the Chinese invented paper. By the 700's, the Chinese, Japanese, and Koreans were using block printing. They carved symbols and pictures on wood blocks, inked the raised images, and transferred the ink to paper.

Printing with process colors

To reproduce a color picture, printers usually make four printing plates—one each to print yellow, magenta, cyan, and black ink. In reproducing the picture of the apple, printers first printed the yellow plate. Then they printed the magenta plate, producing a picture made up only of yellow and magenta tones. Printing the cyan plate next made a picture of yellow, magenta, and cyan tones. The black plate was then printed to add sharpness to the picture. The magnified area shows how the colors of all the plates combine to form the tones of the picture.

WORLD BOOK photos



Yellow plate — Magenta plate — Cyan plate — Black plate

Yellow and magenta — Yellow, magenta, and cyan — Yellow, magenta, cyan, black — Magnified area

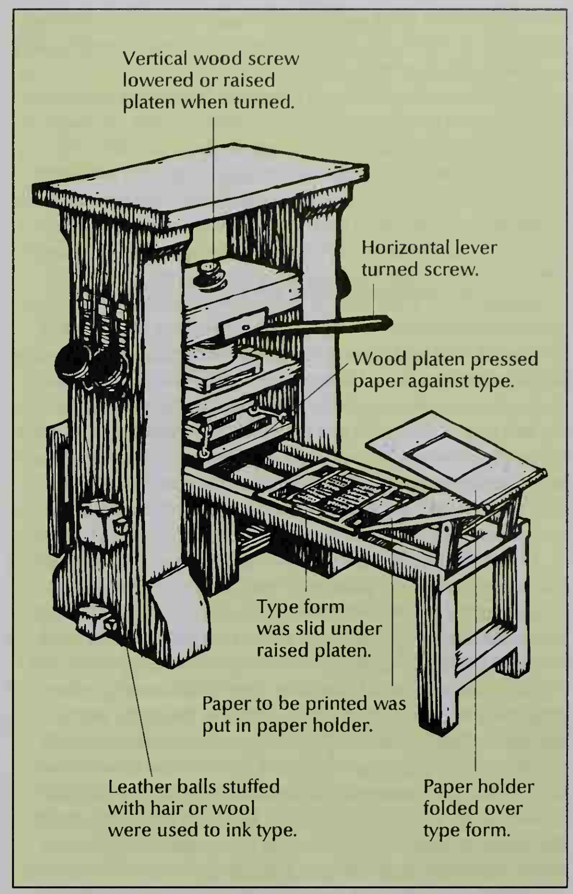
The invention of movable type. About 1045, a Chinese printer named Bi Sheng (Pi Sheng) made the first movable type. He made a separate piece of clay type for each Chinese symbol or character. But the Chinese language required so many different characters for printing that the method was difficult and fell into disuse. Printers found it easier to print from wood blocks.

While the people of East Asia were printing from wood blocks, the people of Europe still copied books by hand. Many monks spent their lives copying books with quills and reeds. In the late 1300's, Europeans discovered wood-block printing. The earliest dated European wood-block print is a picture of Saint Christopher, printed in 1423. About this time, Europeans began to produce *block books* by binding prints together.

Meanwhile, a major revival of art and learning called the Renaissance was sweeping through Europe. The great desire for learning created a huge demand for books that hand copying and block printing could not satisfy. Movable type solved the problem.

Printing as we know it today began about 1440 with the first use of movable type in Europe by Johannes Gutenberg and his associates in Germany. Gutenberg brought together several inventions to create a whole new system of printing. He made separate pieces of metal type, both capitals and small letters, for each letter of the alphabet. He assembled the pieces of type in a frame to form pages. Finally, his press, based on the idea of a wine press, became the first printing press in Europe. Gutenberg had found it hard to produce evenly printed copies by pressing the paper against the type by hand. By turning a huge screw on the press, he could put uniform pressure on the paper. The Gutenberg press could print about 300 copies a day. By 1456, the famous Gutenberg Bible was completed.

Many people feared that the new art of printing was a "black" art that came from Satan. They could not understand how books could be produced so quickly, or how all copies could look exactly alike. In spite of people's fears, printing spread rapidly. By 1500, there were more than 1,000 print shops in Europe, and several million books had been produced.



WORLD BOOK illustration by Tom Dunnington

Gutenberg's press probably looked like this drawing. It was based on the idea of a wine press and could print about 300 sheets a day. It produced the magnificent Gutenberg Bible.

Early printing in North America. In 1539, an Italian printer, Juan Pablos (Giovanni Paoli), set up a print shop in Mexico City. This was the first print shop in North America. In 1639, Stephen Daye and his son Matthew set up the first press in the American Colonies, in Cambridge, Massachusetts.

Printing spread quickly through the colonies, though the colonial authorities often placed strict controls on printers. The early printers were America's first publishers of newspapers, books, and magazines. In 1704, John Campbell established *The Boston News-Letter,* the first regularly published paper in the colonies. In 1751, Bartholomew Green of Boston set up Canada's first print shop in Halifax, Nova Scotia. Green died that same year, and his former assistant, John Bushell, took over the shop. In 1752, Bushell began publishing the *Halifax Gazette,* Canada's first newspaper.

New presses and typecasting machines. There were few changes in the printing press from Gutenberg's time until the 1800's. An English nobleman, the Earl of Stanhope, built the first all-iron press about 1800. In 1811, the German printer Friedrich König invented a steam-powered cylinder press. This press used a revolving cylinder that pressed the paper against a flat bed of type. *The Times* of London used the press for the first time in 1814. It could print 1,100 sheets per hour.

In 1846, Richard M. Hoe of the United States, a manufacturer of printing presses, invented the rotary press. He attached type to a revolving cylinder and used another cylinder to make the impression. The first Hoe presses printed 8,000 sheets per hour. Later models turned out 20,000 sheets per hour. In 1865, William A. Bullock, an American inventor and machinist, found a way to print from a continuous roll of paper and invented a high-speed web-fed rotary press.

Until the 1880's, printers set all type by hand, just as Gutenberg had done over 400 years before. In 1884, Ottmar Mergenthaler, a German instrument maker living in the United States, patented the Linotype. This machine uses a keyboard to cast a full line of type in one piece of metal, thus eliminating the need for hand-setting. In 1887, Tolbert Lanston, an American inventor, developed the Monotype, which casts and sets separate pieces of type.

Developments in platemaking. In 1826, Joseph Nicéphore Niépce, a French physicist, produced the world's first photograph. This achievement, and further

developments in photography, made possible photoengraving, the halftone process, and photolithography and modern offset printing.

In 1852, William H. Fox Talbot, an English photographer, patented photoengraving. Two American photoengravers, Max and Louis Levy, perfected the halftone screen in the 1880's. Alphonse Louis Poitevin, a French chemist, engineer, and photographer, invented photolithography in 1855. By the late 1800's, offset presses appeared in Europe. These early presses were used to print tin sheets for making cans and boxes.

About 1905, Ira Rubel, a U.S. papermaker and printer, accidentally discovered the offset method for printing on paper. While running his press, Rubel unintentionally transferred the inked images onto the rubber-covered impression cylinder, instead of onto paper. Then, when he ran paper through the press, the impression cylinder offset the images onto the paper. Rubel noticed that the offset images were unusually sharp. Improvements in the offset press followed, and offset printing quickly came into general use.

The electronic age. Since the 1930's, more advances have been made in printing than in all the years since Gutenberg. By the mid-1940's, advances in photolithography and offset printing made it possible to print with better quality, consistency, and cost-efficiency than the relief process could offer. The combination of photographic processes and offset printing brought more complex illustrations and photographs to printed pieces, as well as more brilliant and lifelike colors. By the 1960's, photoengraving and offset printing had become so simplified that certain kinds of printing could be done in minutes, giving rise to a new kind of commercial printing called *quick printing.*

Desktop publishing began in the mid-1980's. New computers, computer printers, and software enabled people to design, edit, and print material that traditionally would have been produced on printing presses. In the late 1900's, inventors developed processes for putting images onto paper and other materials directly from computer files, without an intermediate step.

Frank J. Romano

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Goddard, Mary Katherine
Goddard, William
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Zenger, John Peter

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Outline

I. Preparing material for printing
A. Typesetting
B. Preparing illustrations for reproduction
C. Page makeup

II. Methods of printing
A. Offset lithography
B. Relief printing
C. Recess printing
D. Digital printing
E. Other printing processes

III. Printing in color

IV. History

Questions

What were some results of the invention of movable type?
What are the four major printing processes?
How do *line copy* and *continuous tone copy* differ?
What is *desktop publishing*?
Why was the development of photography so important in the history of printing?
Although people of East Asia were the first to use movable type, they did not continue its use. Why?
How are *separation negatives* made for process color printing?
Lithography is based on what fact?
What is a *halftone*?
What is the difference between printing and publishing?

Additional resources

Adams, J. Michael, and others. *Printing Technology.* 4th ed. Delmar Pubs., 1996.
Beach, Mark. *Getting It Printed.* Rev. ed. North Light, 1993.
Pocket Pal: A Graphic Arts Production Handbook. 17th ed. International Paper, 1997.
Steinberg, Sigfrid H. *Five Hundred Years of Printing.* 4th ed. Oak Knoll, 1996.

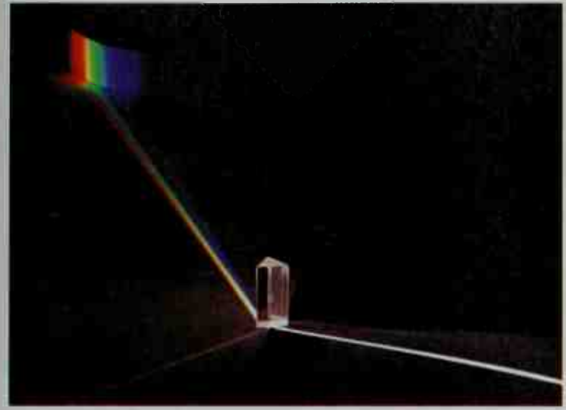
Prion, *PREE ahn,* is a microscopic particle that causes a group of fatal brain disorders called *prion diseases.* Brain tissue damaged by prions looks spongelike under a microscope. Prion diseases include Creutzfeldt-Jakob disease in people, mad cow disease in cattle, and scrapie in sheep and goats. Scientists have not fully determined the structure of prions. But the particles consist largely—and possibly entirely—of a protein called *prion protein.* Most proteins are large molecules with complex three-dimensional shapes. Disease-causing prions contain abnormally shaped forms of prion protein.

Prion protein in its normal shape occurs naturally in the brains of all mammals and birds. The leading explanation for prion diseases is that once the misshapen protein enters the brain, it transforms the normal protein to an abnormal shape. Newly deformed prion protein then transforms more normal protein until brain function is destroyed. Disease-causing prion protein can enter the brain as an infectious agent from outside the body. Abnormal forms can also arise within the brain. The transformation may begin spontaneously or occur due to an error in a *gene* (a unit of heredity that determines the structure of proteins). Infectious prions are unique because they have no genes of their own. All other known infectious agents contain genetic material.

Stanley B. Prusiner

See also **Creutzfeldt-Jakob disease; Mad cow disease.**

Prism is a solid that has two parallel bases joined by three or more *lateral surfaces* (sides). The bases are



Arnold Ryan

A prism splits a beam of white light, *lower right,* into a band of colors called a *spectrum, upper left.* The light ray at the lower left is a reflection of the original beam.

polygons that have the same size and shape. The lateral surfaces are parallelograms.

There are many types of prisms. The simplest has triangular bases. In a *right prism,* the lateral surfaces are perpendicular to the bases. Prisms that do not have this property are called *oblique prisms.*

Prisms form an important class of optical elements. Prisms made of glass or quartz are used in a variety of instruments to change the direction of a beam of light. For example, periscopes contain right prisms that reflect light at a right angle to its original direction. In binoculars, the direction of the light is reversed after the light is reflected off two sides of the prism.

Prisms also can change the direction of a beam of light by means of *refraction*—that is, they can bend the light as it passes through them. The angle at which light is refracted depends on its wavelength. Different colors of light have different wavelengths. If a beam of white light, which contains all the wavelengths of visible light, passes through a prism, it is split up to form a band of colors called a *spectrum.* For this reason, prisms are part of spectrometers and other instruments that measure the spectral composition of light. Brian J. Thompson

Related articles in *World Book* include:

Binoculars (diagram)	Polygon
Color (The relation between color and light; diagram)	Refraction
	Spectrometer
Light	Spectrum

Prison is an institution for confining and punishing people who have been convicted of crimes. Prisons punish criminals by severely restricting their freedom. For example, prisons limit where *inmates* (prisoners) may go, what they may do, and with whom they may associate. Inmates serve sentences ranging from a year to the rest of their lives. Prisons are important because they help protect society from dangerous criminals.

Prisons throughout the world hold more than 8 million people. Russia and the United States have the highest percentages of prisoners in their populations. Denmark, France, Germany, Italy, Japan, the Netherlands, and Sweden have relatively low prison populations.

In some countries, such as Israel and the Philippines, the federal government operates the prisons. The major political divisions of the United Kingdom each have their own prison agency, called the Prison Service in England and Wales, the Scottish Prison Service, and the Northern Ireland Prison Service. In Australia and India, the states have responsibility for running the prisons. In Canada and the United States, both the federal government and the state or provincial governments maintain prison systems. The Federal Bureau of Prisons oversees federal prisons in the United States, and the Correctional Service of Canada operates those in Canada.

Types of correctional institutions

There are various names for institutions that confine convicted lawbreakers or people awaiting trial. The most common terms include *penitentiaries, correctional centers, correctional facilities,* and *reformatories.* Many people consider prisons to be only those institutions that confine adults convicted of major crimes. Institutions for youthful offenders include *training schools* and *juvenile detention centers.* In addition, such facilities as *city and county jails, federal detention centers,* and *metropolitan correctional centers* hold people who are awaiting trial or serving sentences for minor offenses. Most prisons house only male or only female inmates.

Experts classify prisons by the degree of security or control they provide. The main types are (1) maximum security prisons, (2) medium security prisons, and (3) minimum security prisons.

Maximum security prisons generally hold prisoners serving long sentences. These prisoners have committed murder, robbery, kidnapping, treason, or other *felonies* (serious crimes).

High stone walls or strong chain fences surround most maximum security prisons. Many of these barriers have electronic detection devices and powerful spotlights. Prisoners live in cells with steel bars or heavy gratings on one side. Many cells do not have windows. Inmates eat in their cells or in a dining hall. Prison officials limit the length and number of visits by family and friends. During such visits, thick glass or wire screens separate some prisoners and visitors to prevent the exchange of such items as drugs and weapons. Other prisoners and visitors are allowed to be together. Some prisons use X-ray devices to check visitors for weapons.

Since the mid-1980's, a number of prison systems have developed *supermaximum security prisons,* often called *supermax prisons.* These prisons hold prisoners who cannot be controlled by other means. Common features of supermax prisons include total separation, restricted movement, and limited access to staff members and other inmates.

Medium security prisons hold inmates who have committed either felonies or *misdemeanors* (crimes less serious than felonies). Common misdemeanors include assaults and small thefts. The inmates in medium security prisons are generally less dangerous than inmates of maximum security prisons. Some medium security prisons resemble campuses, though they may be surrounded by fences with guard towers. Inmates may live in dormitories or in private rooms. Many of these prisons have educational and athletic facilities.

Minimum security prisons are the most open and least restrictive prisons. Inmates of minimum security prisons are not considered dangerous and are unlikely



B. Charlon, Gamma/Liaison

A maximum security prison holds prisoners convicted of the most serious crimes. Such prisoners may leave their cells only to eat, work, or participate in educational programs.

to flee prison. Many of these inmates were convicted of such nonviolent crimes as forgery, cheating on taxes, business theft, perjury, and obstruction of justice. They live in comfortable rooms and usually may move about within the prison as they please. Minimum security prisons range from large institutions to small farm or forestry camps. Some of these prisons have tennis courts, swimming pools, and golf courses.

Juvenile correctional institutions generally hold offenders under the age of 18. The institutions keep young prisoners from the bad influence of dangerous adult criminals. Juvenile detention centers, called *remand centres* in the United Kingdom, hold young people who have been accused of committing crimes and are awaiting trial. Training schools are institutions where convicted youths serve their sentences. Most of these sentences last about a year. Training schools offer counseling, education, job training, and recreation. The inmates live and eat together in cottages or dormitories that hold fewer than 20 prisoners.

Jails, also spelled *gaols,* hold people awaiting trial. They also house people convicted of the least serious crimes. Jail inmates include people accused of serious crimes as well as such offenders as disorderly and intoxicated persons. Prisoners may stay in jail for only a few hours or for more than a year.

Conditions in most jails are worse than those in other correctional institutions. Jails often are overcrowded, and the same facility may hold both men and women, and adults as well as juveniles. Some prisoners are kept in small cells, and others are crowded together in large cells. Many jails do not meet minimum health and safety standards, and some cells lack a sink or a toilet. Most jails have few professionally trained staff members.

How prisons operate

Prisons have four major purposes. These purposes are (1) *retribution,* (2) *incapacitation,* (3) *deterrence,* and (4) *rehabilitation.* Retribution means punishment for crimes against society. Depriving criminals of their freedom is a way of making them pay a debt to society for their crimes. Incapacitation refers to the removal of criminals from society so they can no longer harm innocent people. Deterrence means the prevention of future crime. Supporters of deterrence hope that prisons provide warnings to potential criminals, and that the possibility of going to prison will discourage people from breaking the law. Rehabilitation refers to activities designed to change criminals into law-abiding citizens. Rehabilitation efforts may include providing educational courses, teaching job skills, and offering counseling with a psychologist or social worker.

Through the years, prison systems have stressed the four major purposes differently. As a result, prisons differ in the makeup of their staffs, the design of their buildings, and their operations.

The prison staff is headed by a *warden, superintendent,* or *governor* who directs the operation of the prison. This official is held responsible if there are such problems as riots, escapes, prison mismanagement, and brutality toward prisoners. *Prison guards,* also called *warders,* observe and supervise the inmates. Many prison guards take an examination to qualify for their jobs. Many prison staffs also include teachers, social workers, psychologists, and doctors and nurses.

Prison buildings vary greatly in design. Prisons built in the *radial design* resemble the hub and spokes of a wheel. The cells, dining hall, and other facilities extend from the control center at the hub. Guards at the control center can observe all activity within the building. Most maximum security prisons use the *telephone pole design.* They consist of a long corridor crossed by shorter corridors that hold the cells and other facilities. Prisoners must use the central corridor when they move from place to place. This design allows close supervision by the guards. The *high-rise design* is a vertical version of the telephone pole design. Prisoners move from floor to floor by elevator. The *campus design* resembles a group of small apartment buildings around a town square. It is commonly used for juvenile institutions and may include such facilities as a church, a school, and a library.

Prison cells are generally small and simply furnished. Some may contain only a bed, a sink, and a toilet. Prisoners who are hard to control may be placed for a time in a *segregation cell* (solitary confinement). Most segregation cells have dim lighting, poor ventilation, and inadequate sanitary facilities. Segregation cells may have only a mattress on the floor or a stone slab on which the prisoner sleeps.

Special facilities and services may be provided for inmates, depending on the views of prison officials and the availability of funds. Prisons may have libraries and athletic facilities for inmates. Prisons may offer counseling, medical care, motion pictures, and religious services. Some prisons offer courses for high school or college credit, or provide job training in such fields as automobile repair and carpentry.

Some prisons operate their own farms or factories and use inmates as workers. Some of these prisons pay inmates for their labor. By providing goods for the prisoners' use, prison farms and factories help prisons reduce their operating costs. China, Poland, and the Netherlands, in particular, emphasize reform through prison labor. Some prisons run *work-release programs,* in which trusted inmates may leave prison during the day for an outside job.



A cell in a maximum security prison has steel bars to keep the prisoner inside. Other features of this cell include a bed, a cylindrical seat, and a table, a corner of which can be seen above the seat.

© Ferry, Gamma/Liaison

History

Early prisons. Before the 1700's, governments seldom imprisoned criminals for punishment. Instead, they imprisoned people who were awaiting trial or punishment. Common punishments at that time included branding, fines, whipping, and *capital punishment* (execution). The authorities punished most offenders in public to discourage others from breaking the law.

English and French rulers kept their political enemies in such prisons as the Tower of London and the Bastille in Paris. People who owed money went to *debtors' prisons.* In many cases, offenders' families could stay with them and come and go as they pleased. But the debtors had to remain in prison until their debts were settled.

During the 1700's, many people criticized the use of executions and other harsh punishments. These critics included the British judge Sir William Blackstone. As a result, governments turned more and more to imprisonment as a form of punishment.

Early prison reform. Early prisons were dark, dirty, and overcrowded. They locked all types of prisoners together, including men, women, and children, plus dangerous criminals, debtors, and the insane. During the late 1700's, the British reformer John Howard toured Europe to observe prison conditions. His book *The State of the Prisons in England and Wales* (1777) influenced the passage of a law that led to the construction of the first British prisons designed partly for reform. These prisons attempted to make their inmates feel *penitent* (sorry for doing wrong) and became known as *penitentiaries.*

In 1787, a group of influential Philadelphians, mostly Quakers, formed the Philadelphia Society for Alleviating the Miseries of Public Prisons (now the Pennsylvania Prison Society). They believed that some criminals could be reformed through hard work and meditation. The Quakers urged that dangerous criminals be held separately from nonviolent offenders and men and women prisoners be kept apart. These ideas became known as the Pennsylvania System, and were put into practice in 1790 at Philadelphia's Walnut Street Jail. Historians consider this jail the first prison in the United States.

The Pennsylvania System was the first attempt to rehabilitate criminals by classifying and separating them on the basis of their crimes. As a result, the most dangerous inmates spent all their time alone in their cells. In time, the system failed, chiefly because overcrowding made such separation impossible. Some inmates in this system became insane because of long isolation.

During the 1800's, New York prison officials developed two major systems of prison organization—the Auburn System and the Elmira System. The Auburn System, introduced at Auburn (New York) Prison in 1821, became widely adopted. Under this system, prisoners stayed in solitary confinement at night and worked together during the day. The system emphasized silence.

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Guard towers and high fences surround many maximum security prisons. Prisoners dressed in white can be seen inside the fence that surrounds this prison. On the tower, a guard with a rifle watches over the prison yard.

Prisoners could not speak to, or even look at, one another. Prison officials hoped that this silence and isolation would cause inmates to think about their crimes and reform. They believed that the prisoners' spirit must be broken before reform could take place. However, the system failed partly because the rigid rules and isolation drove inmates insane.

In 1876, the Elmira (New York) Reformatory opened as a model prison for offenders between the ages of 16 and 30. The Elmira System made use of *indeterminate* (flexible) sentences and allowed prisoners to earn *parole* (early release) for good behavior. In addition, it offered physical and military training and an educational program. The reformatory's emphasis on rehabilitation through education became its major contribution. However, it did not fully achieve its expectations, largely because it judged inmates on their prison behavior instead of on their actual fitness for release. Studies showed that most inmates committed new crimes after their release.

Reforms in the 1900's led to further improvement of prisons. In the 1930's, for example, prisons began to develop rehabilitation programs based on the background, personality, and physical condition of the individual inmate. This approach made rehabilitation programs more meaningful. But despite such efforts, attempts to rehabilitate offenders had disappointing results. Many failed because of poorly trained staffs, lack of funds, and ill-defined goals.

By the 1960's, many people felt that criminals could be helped better outside prison. As a result, federal and state governments began to set up *community correctional centers* and *halfway houses*. Offenders lived in these facilities just before release and received counseling to help them adjust to life outside prison. The number of prison inmates declined. But community correction programs also failed to meet expectations, and prisons again became the most preferred institution.

Since the 1990's, many prison systems have moved toward the *privatization* of prisons. Privatization refers to the transfer of specific activities and responsibilities—such as providing work, health care, or training for inmates—to private agencies. In some cases, private agencies have taken over the running of entire prisons. The United Kingdom, Australia, and the United States have experimented with private prisons. Many people believe that this privatization will lead to increased efficiency. However, others question whether government should transfer the punishment of criminals to private hands.

Prisons today

Current problems. Severe overcrowding ranks as the major problem in most prisons. The overcrowding has developed because of new laws that require longer sentences, eliminate parole for certain crimes, and increase the number of crimes that require imprisonment.

Some judges in the United States have ruled that many prisons are so crowded that they violate prisoners' constitutional protection against "cruel and unusual punishments." Conditions have become so bad in some places that prisoners have been held in warehouses, tents, and house trailers. Many states have had to build more prisons or release inmates early to make room for new prisoners.

There are also concerns among health professionals and human rights groups regarding supermax prisons. In these prisons, inmates may be confined for up to 24 hours a day. Extreme social isolation of this kind can be emotionally and psychologically damaging, and inmates released from such an environment may be a great threat to society.

Prisons face other problems as well. A lack of adequate funding has made improvements difficult. In addition, tensions among prisoners and between prisoners and the prison staff often run high and lead to brutal attacks. Such conditions, worsened by overcrowding, have contributed to several prison riots since the late 1960's. In one of the most serious riots, 33 inmates and 10 prison staff members were killed in a rebellion at the Attica (New York) Correctional Facility in 1971.

Continuing debate. These current problems have brought attention to the continuing debate about the purposes and effectiveness of prisons. Studies have shown that even good rehabilitation programs fail to reform many released prisoners. The apparent failure of such programs has led many people to stress imprisonment as punishment rather than as treatment. On the other hand, experts also have failed to prove that prisons reduce the crime rate either by incapacitating offenders or by discouraging people from breaking the law. For this reason, some experts believe that it would be cheaper, more humane, and more productive to keep most offenders in community correctional centers rather than in prisons. They argue that only the most dangerous criminals should be imprisoned.

Some courts have experimented with sentences that allow criminals to remain out of prison. Some of these sentences impose house arrest enforced by electronic monitoring. Other sentences require criminals to hold a job, repay their victims, perform community service and receive counseling. James O. Finckenauer

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Additional resources

Hjelmeland, Andy. *Prisons: Inside the Big House.* Lerner, 1996.
Morris, Norval, and Rothman, D. J., eds. *The Oxford History of the Prison.* Oxford, 1995.

Prisoner of war is a captured member of a warring country's armed forces. In most cases, prisoners of war have surrendered to their enemy. But sometimes they have been taken by force. Prisoners of war are often called *POW's*.

In 1785, the United States and Prussia signed the world's first treaty calling for fair treatment for prisoners of war. The Hague Conventions of 1899 and 1907 and the Geneva Conventions of 1929 and 1949 established international rules dealing with the treatment of prisoners of war. Nearly all nations have agreed to follow these rules.

The Hague and Geneva conventions require that nations keep their prisoners of war in safe, sanitary camps. Representatives of nonfighting countries must be allowed to inspect the camps. These inspectors make certain that prisoners of war receive food, medical care,

and payment for work. The conventions also rule that nations must permit their prisoners to send and receive mail. Another regulation requires that countries return captured military doctors and chaplains to their own forces. The conventions provide that a prisoner need not give the enemy any information except the prisoner's name, rank, military serial number, and age.

In spite of the Geneva and Hague regulations, much mistreatment of prisoners of war has occurred. During World War II (1939-1945), Germany, Japan, and the Soviet Union treated their prisoners harshly. Millions of them died of cold, starvation, or mistreatment. During the Korean War (1950-1953), United Nations (UN) forces accused the Chinese and the North Koreans of *brainwashing* their prisoners (see **Brainwashing**). By the end of the Vietnam War (1957-1975), 651 American and thousands of North Vietnamese prisoners of war returned to their own countries.

After fighting ended in the Persian Gulf War in 1991, the United States and its allies began releasing the more than 60,000 Iraqis who had been taken prisoner. All 35 allied troops held by Iraq also regained their freedom.

Robert J. Pranger

See also **Geneva Conventions; Katyn Massacre; Korean War** (The truce talks).

Additional resources

Doyle, Robert C. *Voices from Captivity: Interpreting the American POW Narrative.* Univ. Pr. of Kans., 1994.

Garrett, Richard. *P.O.W.* 1981. Reprint. Borgo Pr., 1989. A survey from the Hundred Years' War to Vietnam.

Prisons, Federal Bureau of, an agency of the United States Department of Justice, has responsibility for the custody and care of all prisoners of the federal government. Most of these prisoners have been sentenced. Others are awaiting trial or sentencing. Still others are illegal aliens who have been detained by the government.

The Bureau of Prisons operates dozens of facilities, including high-security penitentiaries, medium- and low-security correctional institutions, and minimum-security prison camps. It also has prison hospitals and other specialized facilities. Some federal prisoners are held in state, local, or private correctional institutions. The bureau pays for the support of these prisoners.

Critically reviewed by the Federal Bureau of Prisons

See also **Prison.**

Privacy, Right of, is the right claimed by individuals to control the disclosure of personal information about themselves. It also covers people's freedom to make their own decisions about their private lives in the face of government attempts to regulate behavior.

The Constitution of the United States guarantees a number of privacy rights. The Fifth Amendment, for example, upholds the right to refuse to testify against oneself in a criminal case. The Fourth Amendment protects a person against unreasonable searches and seizures by government officials. The Supreme Court of the United States has ruled that the Constitution also protects privacy in certain matters relating to marriage, reproduction, birth control, family relationships, and child rearing and education.

Privacy is also protected by a branch of civil law called *tort law.* Under tort law, one person can sue another for violation of privacy in any of four categories: (1) disclosing private facts that are not newsworthy; (2) portraying a person in a false light; (3) using a person's image or personal facts for profit without the person's permission; and (4) intruding into a person's private physical space.

But federal law permits a number of activities that might be considered violations of privacy. For example, a person may intercept or record a conversation between two or more other persons with the consent of only one of those persons. Law enforcement officials, with a court order or other form of approval, may intercept calls without the consent of any party to the conversation. In most cases, employers may legally monitor employees' telephone conversations, electronic mail, and voice mail.

Computer systems enable many organizations, including government agencies, financial institutions, and health care providers, to collect information on a person without the individual's knowledge. Such information, as well as electronic mail and digital photographs of individuals, can be circulated worldwide on the vast computer network called the Internet.

Organizations collect information on individuals to investigate or prevent crime, to manage vast service programs, or to determine a person's eligibility for—or interest in—credit, insurance, education, or other services. Since the 1970's, however, Congress and the states have passed laws that restrict disclosure of personal information and give individuals the right to challenge the accuracy of information about themselves. These laws cover federal agencies, school records, credit reports, and telephone solicitation. In addition, the law holds that most privileged conversations with lawyers, spouses, clergy, and others are confidential. Robert Ellis Smith

See also **Computer** (Computer security); **Libel; Search warrant; Wiretapping.**

Private school generally refers to any school that is not controlled by government authorities and is not supported chiefly by taxes or other public funds. A private school differs from a *public school,* which operates under public supervision with major support from government funds. Private schools are operated by religious groups and by independent nonreligious organizations seeking educational approaches not sufficiently represented in public schools.

Most private schools operate on a nonprofit basis, although a few are run as businesses to make money for their owners. Private schools are funded chiefly by tuition, grants from their sponsors, or contributions. Some private schools also have an *endowment*—that is, invested money whose income is used to fund the school.

In most countries, almost all schools were private until the early 1800's. At that time, many government leaders began to encourage development of public schools to foster national progress by making education widely available to citizens. Today, the number of public and private schools differs greatly from one country to another. In many developed countries, private schools offer popular alternatives to programs in public schools. Such alternatives include a general focus on preparation for college; a special focus on science, music, or other subject areas; and religious instruction. The Roman Catholic Church is one of the largest sponsors of private schools throughout the world. Other private schools are operated by Protestant, Jewish, and Islamic groups in

many countries. Arthur G. Powell

See also **Military school; Parochial school; Universities and colleges** (Kinds of universities and colleges).

Privateer, *PRY vuh TIHR,* is a privately owned armed vessel. Before the development of strong navies, many nations commissioned privately owned ships to assist them in time of war. Such commissions, first used in the 1400's, were known as *letters of marque and reprisal,* and ships and crews acting under them were called privateers. The privateers attacked merchant ships of the enemy nation and sank or robbed them. Unlike pirates, privateers operated with their government's permission.

Privateers helped the colonies against Britain in the Revolutionary War in America (1775-1783). On March 18, 1776, the Second Continental Congress authorized privateers. This action was taken after the British Parliament had prohibited all trade with the colonies and authorized seizure of their ships. George Washington was part owner of at least one privateer. Colonial privateers captured about 600 British ships.

From 1798 to 1801, the United States authorized privateers to seize French vessels, because many American ships were being taken by warships of republican France. In the War of 1812, American privateers seized 1,345 British ships. Some became pirates after the war. In 1856, the United States refused to sign the Treaty of Paris outlawing privateering because it feared it might need privateers to support its weak navy.

During the American Civil War (1861-1865), the Confederate government issued letters of marque. But after the first year of war, a volunteer naval system was substituted for privateering. The federal government tried privateering in 1863, and Chile used it against Spain in 1865. These were the last known instances of privateering. John W. Gordon

Privatization is the transfer of government programs, assets, or responsibilities to private individuals or organizations. There are many different types and degrees of privatization. In the purest form of privatization, a government would completely sell a state-owned business to private investors. In a less strict form of privatization, a government might hire private organizations to deliver public services. The opposite of privatization is the process of *nationalization,* by which a government increases its ownership of a country's industries and resources.

Many Western nations have privatized such functions as air travel and telephone service. Following the breakup of the Soviet Union in 1991, many former Soviet republics and Eastern European countries that had been dominated by the Soviet Union undertook large-scale privatization of their nationalized industries. Some other countries have hired private organizations to provide health care, airport management, and road construction.

When handled effectively, privatization can lower costs and increase flexibility in providing services. Privatization is not always successful, however. Some private buyers might lack the resources or expertise to manage public services effectively. Therefore, privatization efforts require careful planning and implementation to improve the chances for success. Donald F. Kettl

See also **Nationalization.**

Privet, *PRIHV iht,* is the name of a group of flowering shrubs. The common privet is planted in many parks and gardens of North America. It is native to southern Europe and northern Africa. Other species of privets grow wild in Asia and Australia. All parts of privets are poisonous if eaten. The common privet is usually kept trimmed as a hedge but is sometimes cultivated as a large bush as much as 15 feet (4.5 meters) tall. Its white flowers are much smaller and less showy than those of the lilac, its close relative, but are similar in shape. Their odor is less sweet than that of the lilac. The common privet's smooth, dark-skinned fruit resembles a tiny olive. Some *cultivars* (varieties) have white, yellow, or greenish-yellow fruits. Fred T. Davies, Jr.

Scientific classification. Privets belong to the olive family, Oleaceae. The scientific name for the common privet is *Ligustrum vulgare.*

Privy Council, *PRIHV ee,* is an honorary council appointed by the Crown of the United Kingdom. Members of the Privy Council include Cabinet members, other political leaders, judges, and scholars. Privy councilors are selected from all countries in the British Commonwealth that recognize the British monarch as their symbolic head of state. The title of councilor is honorary in most cases. Council members become salaried officials only when given a place in the Cabinet. The lord president of the council is a member of the British Cabinet.

Council members serve during the life of the sovereign who appointed them, and for six months after the sovereign's death. The full council meets on rare occasions, such as the beginning of a reign, or when the reigning sovereign announces his or her marriage. The administrative work of the council is carried on through state departments. Each department is headed by a minister responsible to Parliament. The Judicial Committee is the highest judicial authority in the British Commonwealth. Members of the Privy Council use the title *Right Honourable* before their names, and letters *P.C.* (privy councilor) after their names.

The beginning of the Privy Council can be traced to the council of William the Conqueror. The council advised William the Conqueror on matters of state, and set the laws for the kingdom. The importance of the council declined as Parliament increased in power.

The British North America Act of 1867 established the King's (or Queen's) Privy Council for Canada. The Cabinet of the Dominion of Canada sits as a committee of the Canadian Privy Council. Arthur I. Cyr

Probability. When we say that one event is more probable than another, we mean it is more likely to happen. The branch of mathematics called *probability* tries to express in numbers statements of the form: An event *A* is more (or less) probable than an event *B.*

If a person tosses a coin, there are only two ways it can fall—heads or tails. It is as likely to fall one way as the other. Thus we say that the probability of throwing heads is $\frac{1}{2}$. If the coin is tossed 100 times and x is the number of times heads occurs, we can expect the ratio $\frac{x}{100}$ to be close to $\frac{1}{2}$. More generally, if a coin is tossed n times and x is the number of times heads occurs, the ratio x/n will be very close to $\frac{1}{2}$ if n is very large.

Now suppose a person tosses three coins. There are eight possible outcomes: *hhh, hht, hth, thh, htt, tht, tth,* and *ttt. Three* of these outcomes have two heads, so the probability of throwing two heads is $\frac{3}{8}$. Only *one* outcome has exactly three heads, so the probability of

throwing three heads is $\frac{1}{8}$. The event *two heads* is more probable than the event *three heads.* If a set of three coins is tossed a very large number of times, we would expect two heads to occur very nearly $\frac{3}{8}$ of the time and three heads to occur very nearly $\frac{1}{8}$ of the time.

Probability is the foundation of the science of statistics. A political scientist, for example, may gather data and use statistics to predict the percentage of voters who will vote for a particular candidate in an election. The political scientist then uses probability to calculate the possible error of the estimate. Thomas J. Brieske

See also **Fermat, Pierre de; Pascal, Blaise; Statistics.**

Probate. When people die, their wills must be *probated* (proved to be genuine). A deceased person's executors bring the will before a court where wills and estates are handled. This court is usually called the *probate court.* The executors present the will and show proof that it is the true will of the deceased. A will should be offered for probate soon after the death of the person who made it, called the *testator.* After the will is presented, the court usually issues a notice to the testator's heirs who would have shared the property if no will had been made. A hearing is then held in the court, and the heirs are given a chance to object to the will. The judge then decides if the will is genuine. In many states, a jury makes this decision.

A will may be denied probate if the testator lacked mental capacity or was subjected to undue influence. If all requirements have been met, the will is approved, and the executors carry out its provisions.

William M. McGovern

See also **Executor; Will.**

Probation is a judicial act that allows a convicted criminal to remain free in society instead of serving a sentence in prison. Probation is most frequently granted by a judge to juveniles or to people who have been convicted of an offense other than the most serious crimes, such as armed robbery, murder, or rape. Probation gives such people a chance to prove that they will not repeat their crime. The word *probation* comes from the Latin word for *prove* or *test.*

Many criminologists believe that probation encourages good conduct by the *probationer* (person on probation). Probation enables the offender to avoid the harmful effects of being imprisoned with experienced criminals. It also costs the taxpayers less than imprisonment because a probationer does not have to be fed, clothed, housed, and guarded in a jail.

When a judge decides to grant probation, he or she places the offender under the supervision of a court official called a *probation officer.* The judge also sets the period of probation, which can range from six months to five or more years. During this time, the probationer must follow certain rules of conduct called *conditions of probation.* The probationer also must meet regularly with a probation officer to discuss any problems or other matters connected with the case.

At the end of the probation period—if the probationer has avoided getting into trouble—the trial judge releases the probationer from all supervision. But if the conditions of probation have been violated during the probation period, the probation officer may report the violations to the judge. The judge may send the probationer to prison for the original crime if the wrongdoer has violated any of the conditions of probation.

Probation differs from *parole* and *pardon.* Parole is the release of a convict who has served part of a sentence. A pardon excuses a person from any punishment for a crime. Charles F. Wellford

Problem solving. See **Education** (How people learn); **Science** (How scientists work).

Proboscis monkey, *proh BAHS ihs,* is a large, leaf-eating monkey that lives on the island of Borneo in Southeast Asia. It gets its name from its *proboscis* (long nose). A male weighs up to 52 pounds (24 kilograms), and a female weighs up to 26 pounds (12 kilograms). These monkeys are from about 21 to 30 inches (53 to 76 centimeters) long, not including the tail.

Adult proboscis monkeys have reddish hair on their heads, backs, shoulders, and thighs, and pale gray hair on the arms and legs. Infant monkeys are born with silver-blue fur that turns gray after about three months. Proboscis monkeys have sharp back teeth that enable them to shred leaves easily. They have a well-developed thumb adapted to picking leaves and other plant parts. These monkeys live in trees near rivers. They feed mainly on leaves and also eat fruits and flowers.



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The proboscis monkey gets its name from its *proboscis,* or long nose. An adult proboscis monkey, such as the one pictured here, has reddish hair on its head, back, shoulders, and thighs.

Proboscis monkeys are good swimmers. Crocodiles prey on them in rivers and streams. But clearing of trees in their environment for agricultural purposes is the main threat to the animal's existence. Randall L. Susman

Scientific classification. The proboscis monkey belongs to the Old World monkey family, Cercopithecidae. Its scientific name is *Nasalis larvatus.*

See also **Monkey** (picture).

Procaine, *PROH kayn,* is a drug used to block pain sensation in a specific part of the body. Such drugs are called *local anesthetics.* Doctors use injections of procaine to produce *regional nerve blocks* and *spinal anesthesia* (see **Anesthesia** [Local anesthesia]). It is often called by the trade name *Novocain.* Procaine is a white,

crystalline powder. It is chemically similar to the local anesthetics benzocaine and cocaine. But, unlike those anesthetics, it does not produce anesthesia when applied to the surface of the skin or mucous membranes.

A German chemist, Alferd Einhorn, first synthesized procaine in 1905. It soon replaced cocaine as the drug of choice for regional nerve block anesthesia, and for many years, it served as the standard to which other local anesthetics were compared. The use of procaine has declined since the introduction of the local anesthetic lidocaine in the 1940's. Edwin S. Munson

See also **Benzocaine; Cocaine; Lidocaine.**

Proclamation is an executive notice issued under the authority of the head of a state or country. It announces some order or regulation that is important to the people. A proclamation that grants a pardon to rebels is a *proclamation of amnesty.* Usually a proclamation appears in printed form. See also **Emancipation Proclamation.** Sherman L. Cohn

Proclamation of 1763. See **Revolutionary War in America** (The Proclamation of 1763).

Producer. See **Motion picture** (How motion pictures are made); **Theater** (The producer).

Product liability suit is a legal action brought against a business accused of placing a defective or unreasonably dangerous product on the market. In most cases, the plaintiff claims to have been harmed by a product made or sold by the defendant. Product liability may be based on manufacturing or design flaws, or on *informational defects.* Informational defects include inadequate warnings or instructions for use. Product liability is usually limited to products sold or leased as new.

To win a product liability suit, the plaintiff generally must prove that a product's defective or unreasonably dangerous condition caused personal injury, death, or property damage. If a suit is successful, the plaintiff may receive payment for medical expenses, lost earnings, pain and suffering, disability, *disfigurement* (damaged appearance), or property damage. Many companies carry insurance to protect against product liability suits.

In the United States, liability for defective products may be based on (1) *strict liability,* (2) *negligence,* or (3) *breach of warranty.* A court can impose strict liability on a company if it manufactured or distributed a product that was defective when it left the company's control. In some cases, the plaintiff does not have to prove that the defendant knew or should have known about the defect.

Negligence, in product liability suits, means the defendant carelessly caused the defect or failed to discover it. The plaintiff's own negligence or other fault may reduce or eliminate the defendant's liability.

Breach of warranty means that the product was sold with a defect that violated existing quality or safety provisions. In the United States, breach of warranty claims are based on the Uniform Commercial Code. This code, a body of laws governing buying and selling of goods, has been adopted in whole or part by all the states.

Product liability rules are almost entirely established by the states. Although such laws are similar throughout the United States, there is some variation from state to state. Edward J. Kionka

Production is a major step in the series of economic processes that bring goods and services to people. Other main steps include *distribution* (getting the goods to persons who use them) and *consumption* (the final use of the goods). For example, the producers of a loaf of bread include the people who raise the grain, those who make flour, and those who bake the loaves. The bakery salespeople and the truck drivers who deliver the bread are distributors. Consumers buy and eat the bread. In a balanced economy, production and consumption are about equal and goods flow smoothly from maker to user.

A balanced economy is one in which the vast majority of people who want to work have jobs, and the total amount of production is sufficient to satisfy the needs and wants of the people. When a lack of balance exists, some blame can be placed on consumption, because many persons do not have money to buy goods they want. Other factors, such as technological change, overextension of credit, and improper distribution of goods can unbalance the economy. Daniel Quinn Mills

See also **Consumption; Economics; Factory; Marketing; Mass production; National income.**

Productivity refers to the ability to create goods and services by using available resources, including labor, equipment, and land and other natural resources. Economists frequently measure the productivity of a nation's economy. Their findings often are expressed as the amount of goods and services an average worker can produce over a given period.

A rise in productivity may result from better production methods, more equipment, and higher levels of education among workers. Over long periods, productivity growth can bring dramatic increases in a country's standard of living. For example, before the 1600's, it took as much as 90 percent of a country's workers to produce food for everyone. Today, only about 3 percent of all workers in industrialized countries work in agriculture. As a result, more people have become available to produce other goods and services. Increased productivity can also lower the cost of creating goods and the prices consumers must pay for them. Shelby Gerking

See also **Industry** (Labor productivity); **Wages and hours** (Wages).

Profit is the amount of money a company has left over from the sale of its products after it has paid for all the expenses of production. These expenses include costs of such things as raw materials, workers' salaries, and machinery. They also include a reasonable return on the owner's investment, a salary for the labor the owner supplies to the firm, and other costs that are hard to calculate. A main task of accounting is to define and measure profits accurately.

Profits are vital to the economic system of the United States, Canada, and other countries where private enterprise is encouraged. In such countries, profits belong to the owners of companies or the stockholders of corporations. One of the chief reasons for operating a business is to make a profit. The desire for profits motivates companies to produce their goods efficiently. This is because the lower a company's costs are, the greater its profits can be.

A business can earn a profit only by producing goods and services whose selling price is greater than the cost of production. Therefore, business executives seek to use labor and raw materials to produce and sell things

for which customers will pay a price that is greater than the cost of production. Thus, the search for profits is also the search for the uses of a country's labor and raw materials that will satisfy consumers most completely.

Some business executives constantly lower prices to capture sales and profits from their competitors. But there are several reasons why competition does not eliminate profits. For one thing, at any one time, there will be many firms that have discovered profitable opportunities their competitors cannot yet match. Sometimes, new firms cannot duplicate a profitable product because of patents or trademarks, or for other reasons. Sometimes, new firms cannot produce goods as cheaply as established ones. In addition, the bother and risk of entering an unfamiliar industry keeps some new firms from competing with a product that is not especially profitable. Established firms can then enjoy reasonable profits without fear of new competition. Henry J. Aaron

See also **Capitalism** (Capitalism in its ideal form); **Price; Accounting; Business; Corporation.**

Profit sharing. Many employers share part of their profits with their employees. They do this to encourage productive work and to induce the employees to remain with the company.

Profit-sharing plans are usually based on the net profit of the firm, after all interest, taxes, and other charges against the gross profits have been paid. A certain percentage of the profit is set aside for the employees, and workers share in it according to their salary or their length of service with the company.

Some industrialists object to profit-sharing plans, because workers do not share the responsibilities and risks of the business. Some labor leaders also oppose such plans, believing that workers should concentrate their efforts on obtaining higher wages. But other industrialists and labor leaders believe that properly administered profit-sharing plans promote better understanding between employer and employees, and stimulate efficiency, since both employer and employees share in any gains achieved by joint effort. Daniel Quinn Mills

Progeria, *proh JIHR ee uh,* is an extremely rare disorder that causes premature aging in children. The disease is also called *Hutchinson-Gilford syndrome.* It was first described in 1886 by Sir Jonathan Hutchinson, an English physician. Since then, only about 100 cases have been reported worldwide. The disease occurs only once in every 4 million births. The word *progeria* comes from a Greek word that means *prematurely old.*

Most people with progeria appear normal at birth, but they soon begin to grow more slowly than normal. By 1 or 2 years of age, their hair turns lighter in color and starts to fall out. By age 3 or 4, they are almost bald. In addition, their skin becomes thin, wrinkled, and spotted, their bodies take on a stooped appearance, and their facial features look "pinched." Their heads appear unusually large and veiny.

Many people with progeria develop disorders of the circulatory system, especially high blood pressure, heart disease, and stroke. Some victims die as early as 7 years of age. About half die by age 13. The oldest known person with progeria lived 27 years.

The disease does not affect a person's mental development. Many people with progeria are highly intelligent. Most victims are very shy because of their physical appearance. Although people who have progeria continue to grow slowly, few reach a height of 3 feet 6 inches (107 centimeters) or a weight of 40 pounds (18 kilograms).

Scientists do not know the cause of progeria, and there is no effective treatment. The rareness of the disease makes it difficult to study. F. L. DeBusk

Progesterone, *proh JEHS tuh rohn,* is a hormone produced mainly by the ovaries and the placenta in female animals during the period when they are able to bear young. Small amounts are also produced by the adrenal glands in both females and males and by the testes in males.

Progesterone plays an important role in preparing a woman's uterus for pregnancy. About midway through a woman's monthly menstrual cycle, one of her two ovaries releases an egg. This process, called *ovulation,* causes changes in the ovary so that it releases high levels of progesterone into the blood for 10 to 12 days. Progesterone stimulates the lining of the uterus so that the egg, if it has been fertilized, may attach to the uterine wall. If pregnancy does not occur, the ovary stops producing high levels of progesterone. The uterine lining then breaks down and passes out of the body during menstruation. See **Menstruation.**

The monthly increase of progesterone in a woman's blood after ovulation causes cyclic changes in other body functions. For example, the woman's body temperature increases, and her breasts may enlarge or become especially sensitive. During pregnancy, the placenta produces large amounts of progesterone. The high progesterone level keeps the uterine muscle relaxed so the baby is not born too soon. See **Placenta.**

Physicians use progesterone as a drug to treat disorders of the reproductive system. These disorders include premenstrual tension and irregular menstruation. Synthetic forms of progesterone are used alone and in combination with synthetic estrogens in birth control pills. P. Landis Keyes

See also **Steroid.**

Programmed instruction. See **Computerized instruction.**

Programming See **Computer** (Programming a computer).

Progression, in mathematics, is a sequence of related numbers or symbols called *terms.* The following examples illustrate three common kinds of progressions:

Arithmetic progression: 1,2,3,4,5,6, ... and so on;
Geometric progression: 2,4,8,16,32, ... and so on;
Harmonic progression: $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{6}$, $\frac{1}{8}$, ... and so on.

In each of these progressions, the terms after the first are formed in different ways. Each term of an arithmetic progression is formed by *adding* a quantity called the *common difference* to the previous term. In the example, the common difference is 1. Each term of a geometric progression is formed by *multiplying* the previous term by a quantity called the *common ratio.* In the example, the common ratio is 2. Each term of a harmonic progression is a fraction. The numerators are all 1's, and the denominators are formed like the terms of an arithmetic progression. In the example, the common difference of the denominators is 2.

Progressions are useful in solving many problems in science and business. For example, they simplify the cal-

culation of compound interest (see **Interest**). Mathematicians have developed formulas for finding the value of any term of a progression and for finding the sum of any number of terms.

Arithmetic progressions may have various first terms and common differences, as shown below:

	First term	Common difference	Arithmetic progression
A	2	3	2, 5, 8, 11, 14, 17, ...
B	3	−2	3, 1, −1, −3, −5, ...
C	1	$\frac{1}{2}$	1, 1 $\frac{1}{2}$, 2, 2 $\frac{1}{2}$, 3, ...
D	*a*	*d*	*a, a + d, a + 2d, a + 3d, ...*

In example A, the 4th term (11) is equal to 2 + 3 + 3 + 3, which can also be written 2 + (4 − 1)3. The value of *any* term can be found by adding to the first term the product of the common difference times one less than the number of the term. In general, *a* can be used to represent the first term, and *d* the common difference. The formula for the *n*th term (U_n) is

$$U_n = a+(n-1)d$$

The sum of the first 6 terms of example A is 2 + 5 + 8+11+14+17 = 57. Note that the sum of the first and last terms (2,17) is 19. Likewise, the sums of the 2nd and 5th terms (5,14) and the 3rd and 4th terms (8,11) are also 19. The sum of all 6 terms (57) is equal to 3 times 19, or 3 times the sum of the first and last terms. In general, the sum of any number of terms of an arithmetic progression is one-half the number of terms times the sum of the first and last terms. If we use the symbol *Sn* to represent the sum, the formula is

$$S_n = \frac{n}{2}(a + U_n)$$

Geometric progressions may have various first terms and common ratios, as shown below:

	First term	Common ratio	Geometric progression
A	2	3	2, 6, 18, 54, 162, ...
B	1	$\frac{1}{2}$	1, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$, ...
C	a	r	a, ar, ar^2, ar^3, ... ar^{n-1}, ...

Example C indicates that the value of the *n*th term (*Un*) is ar^{n-1}. The exponent ($n - 1$) means that *r* is to be used as a factor ($n - 1$) times. Using this formula, the 6th term in example A can be calculated:

$$U_6 = 2(3)^5 = 2\times3\times3\times3\times3\times3 = 486$$

The sum of *n* terms can be calculated by the formula

$$S_n = \frac{a-ar^n}{1-r}$$

For example, the sum of the first 4 terms of example A is calculated as follows:

$$S_n = \frac{2-2(3)^4}{1-3} = \frac{2-162}{-2} = 80$$

If *r* is less than 1, the sum of an *infinite* number of terms approaches the limit $a/(1 - r)$. See **Series** (Working with infinite series). Jeffrey C. Barnett

Progressive Conservative Party is the oldest political party in Canada. Until 1942, its name was simply the Conservative Party. Many people still refer to the party by that name. In general, the Conservatives favor tax reform, elimination of the national debt, and tight controls on government spending. Business and professional interests have traditionally supported the party.

The Conservative Party dates back to the 1850's. It grew out of an alliance of conservatives, reformers, and moderates who favored the confederation of British colonies in North America. John A. Macdonald of Upper Canada (later Ontario) was the party's first leader.

After confederation in 1867, the Conservatives gained control of the new country's government. Except for a period of Liberal Party control from 1873 to 1878, the Conservatives held power until 1896. Macdonald served as prime minister from 1867 to 1873 and from 1878 until his death in 1891. Under him, Canada's first transcontinental railroad was built. Macdonald also supported high tariffs in an effort to boost Canadian manufacturing.

The Conservatives lost power to the Liberals in 1896, but they regained control of the government in 1911, when Robert L. Borden became prime minister. In 1917, during World War I, Borden's government began to *conscript* (draft) men for military service. Conscription was highly unpopular in the French-speaking parts of Canada. It cost the Conservatives support in those areas for many years. Borden resigned as prime minister in 1920. Except for three months of Conservative control in 1926, the Liberals held power from 1921 to 1930.

Richard B. Bennett led the Conservatives to victory in 1930. He failed to strengthen the Canadian economy during the Great Depression. But his government established Canada's central bank and the nation's publicly owned broadcasting system. The Liberals defeated the Conservatives in the election of 1935.

The Conservative Party changed its name to the Progressive Conservative Party in 1942. The renamed party did not win a national election until 1957, when John G. Diefenbaker was party leader. As prime minister, Diefenbaker refused to accept atomic warheads for defense missiles supplied to Canada by the United States. He also failed to curb high unemployment in Canada. The Conservatives were voted out of office in 1963.

Brian Mulroney led the party to an overwhelming victory in 1984. His efforts to amend Canada's constitution to satisfy Quebec nationalists failed, and many of his economic proposals proved unpopular. But he signed a free-trade agreement with the United States in 1988.

Mulroney resigned in early 1993. The Conservatives won only two legislative seats in an election later that year. Since then, the party has never won more than a handful of seats. J. L. Granatstein

Progressive education was a revolt against the traditional schools of the United States of the 1800's. It grew from the belief that schools had failed to keep pace with rapid changes in American life.

The traditional school stressed specific subjects—reading, writing, arithmetic, geography, history, and grammar. The teacher lectured or dictated a lesson, and the students copied it in their notebooks. The students then learned by heart what was in their notebooks and recited what they learned from their textbooks. The teacher enforced order and quiet except for recitation periods. Students sat at rows of desks fastened to the floor, and they could not move or talk without permission.

Progressive educators thought that traditional education should be reformed. Famous progressive educators of the 1800's included Francis Parker and G. Stanley



Elsie Ripley Clapp Papers, Special Collections/Morris Library, Southern Illinois University

Learning by doing real tasks was a major educational technique used in progressive education. In this picture, children in a progressive school of the 1930's are building their own village.

Hall. In the early 1900's, John Dewey became a well-known spokesman for progressive education. See **Parker, Francis W.; Hall, G. Stanley; Dewey, John.**

Progressive educators tried to reform elementary school methods in several ways. They thought teachers should pay more attention to the individual child and not treat all children alike. Progressive educators believed children learn best when they are genuinely interested in the material, and not when they are forced to memorize facts that seem useless to them. Children should learn by direct contact with things, places, and people, as well as by reading and hearing about them. Thus, elementary schools should include science laboratories, workshops, art studios, kitchens, gymnasiums, and gardens. Progressive educators believed this procedure would develop the child's physical, social, and emotional nature as well as its mind.

In addition, progressive educators stressed greater freedom, activity, and informality in the classroom. They believed that children learn better when they can move about and work at their own pace. They thought children should gather materials from many sources rather than from just one textbook, and should work together in groups. Discussion, dramatics, music, and art activities became a larger part of classroom procedures.

Progressive education spread most widely through the elementary school level. Teachers planned individual instruction and centered it around projects, units, or activities rather than the usual courses or subjects. They taught students of different abilities in separate groups.

Criticism of progressive education. Many writers and some educators began increasingly to criticize progressive education during the 1940's and 1950's. They charged students did not learn fundamental subjects well enough. Other educators said that students learned as well under progressive education as under traditional methods. But by the early 1960's, many schools had begun to experiment with different teaching methods. Many experiments used "progressive" principles but did not use the term. Douglas Sloan

See also **Education** (New theories of education; picture).

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Progressive movement was a campaign for economic, political, and social reform in the United States. It began during a nationwide depression that lasted from 1893 until about 1897. The movement ended when the United States entered World War I in 1917. Americans turned their attention from reform to war.

Industry in the United States had grown swiftly during the 1800's. This change caused such problems as business monopolies, dishonest politics, city slums, and poor working conditions in factories and mines. In the 1890's and early 1900's, many reformers helped bring about laws aimed at relieving these problems. They began to call themselves *progressives* about 1905. They had their greatest effect at the local and state levels, where the movement began. But the U.S. Congress also adopted some key measures.

Economic reforms of the progressive movement included increased government regulation of business

University of Illinois at Chicago, University Library/Special Collections



Progressive movement reforms included efforts to improve the lives of poor people. This photograph shows a kindergarten at Hull House, a settlement house in Chicago that was a famous center of the progressive movement. Hull House was founded in 1889 by Jane Addams and Ellen Starr.

and a series of tax reforms. In 1890, Congress passed the Sherman Antitrust Act, which banned industrial monopolies that limited competition. But the act had little immediate effect, partly because its wording was vague. Progressives worked for a stronger law to prevent business abuses. In 1914, Congress set up the Federal Trade Commission to stop illegal business practices.

Before the progressive movement, many taxes had been based on property. But many wealthy people hid such property as stocks and bonds from the government and did not pay taxes on them. Largely for this reason, progressives demanded that taxes be based on income rather than on property. In 1911, Wisconsin passed the first effective state income tax law. Two years later, Congress enacted what became the first permanent federal income tax in the United States.

Political reforms. Many city and state governments were controlled by dishonest business executives and politicians who attempted to block economic reforms. But in the 1890's and early 1900's, progressive mayors gained office in a number of cities. These mayors, including Tom L. Johnson of Cleveland and Samuel M. Jones of Toledo, Ohio, worked to end corruption in law enforcement, public transportation, and other city services. Progressives also worked to increase the political power of the voters. In 1903, Los Angeles became the first city to approve *recall,* which allowed voters to remove a person from public office before his or her term ended.

State governments also adopted political reforms. A number of states granted *home rule,* the right of a city to govern itself. In 1898, South Dakota passed the first state *initiative* and *referendum* laws. Under the initiative, voters could pass laws without the need for the state legislature's approval. The referendum enabled voters to overrule laws adopted by the legislature. Wisconsin, led by Governor Robert M. La Follette, adopted the first effective state *direct primary law* in 1904. This law allowed the voters to nominate candidates. Previously, each political party had held a convention at which delegates nominated candidates.

Political reforms on the federal level included the 17th Amendment to the Constitution. This amendment, adopted in 1913, provided for United States senators to be directly elected by the people. The state legislatures had previously elected U.S. senators.

Social reforms of the progressive movement included improvements in the living and working conditions of the poor. Many states passed housing regulations to help relieve crowded city slums. In some slums, progressives set up centers called *settlement houses.* Reformers and slum residents met in them and worked to improve slum conditions. One famous settlement house was Hull House, founded in 1889 by Jane Addams and Ellen Starr, two Chicago social workers.

In many factories and mines, employees worked long hours for low wages and operated unsafe machinery. Progressives helped bring about state laws that required safety precautions in factories and allowed workers to collect money for injuries suffered on the job. Some states also set a minimum wage.

In the early 1900's, writers called *muckrakers* exposed many social and political injustices in the nation. Their works helped bring about many reforms. Leading muckrakers included Jacob Riis, Upton Sinclair, Lincoln Steffens, and Ida Tarbell. Each of these writers has a separate biography in *World Book.*

In spite of their achievements, progressives failed to significantly curb the power of large businesses. However, they exposed injustices and created the patterns of reform that became the basis for reform movements later in the 1900's. David P. Thelen

See also **Addams, Jane; La Follette** (Robert Marion, Sr.); **Roosevelt, Theodore; Taft, William Howard** (Legislative achievements); **United States, History of the** (Reform).

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Progressive Party is a name given to several political parties that have been organized in the United States. In general, the Progressives stood for liberal social, political, and economic reform.

The "Bull Moose" Party. Shortly after the renomination of William Howard Taft in 1912, a group of Republicans left their party to found a new group called the *Progressive Party.* It was nicknamed the "Bull Moose" Party. The Progressives nominated Theodore Roosevelt and Hiram Johnson for president and vice president. They polled more votes in the election than the Republicans, but not as many as the Democrats. The Progressives nominated Roosevelt for president again in 1916 but he refused to run, and most of the Progressive leaders went back to the Republican Party.

The La Follette Progressives. In 1924, a group of farm, labor, and religious leaders formed a new Progressive movement. Senators Robert M. La Follette and Burton K. Wheeler were nominated to run for president and vice president. The Progressives polled nearly 5 million votes, but carried only La Follette's home state, Wisconsin. Robert La Follette's sons, Governor Philip La Follette and Senator Robert M. La Follette, Jr., led the Wisconsin Progressive Party, which had considerable success from 1934 to 1938. In the 1940's, it lost strength. The Progressives voted to merge with the Republicans in 1946.

The Progressive Party of 1948 was formed by various left-wing groups, including the Communists. Henry A. Wallace, former Democratic vice president of the United States, was the party's unsuccessful candidate for president in the 1948 election. Donald R. McCoy

See also **La Follette; Roosevelt, Theodore** ("Bull Moose" candidate); **Wallace, Henry Agard.**

Prohibition, *PROH uh BIHSH uhn,* refers to laws that are designed to prevent the drinking of alcoholic beverages. The laws forbid the manufacture, sale, or transportation of such beverages. Alcoholic beverages include beer, gin, rum, vodka, whiskey, and wine.

In the United States, prohibition became so popular in the early 1900's that, in 1920, a prohibition amendment was added to the U.S. Constitution. This amendment, the 18th Amendment, caused the use of alcoholic beverages to decline sharply. However, many people ignored the national ban and drank illegal beverages supplied by networks of bootleggers. The 18th Amendment

was abolished in 1933. It is the only amendment to the U.S. Constitution that has ever been repealed. Canada, Finland, and Norway also outlawed intoxicating beverages during the early 1900's.

Prohibition in the United States

The movement toward prohibition. In the 1600's and 1700's, the American colonists drank large quantities of beer, rum, wine, and hard cider. Such alcoholic beverages were often safer to drink than impure water or unpasteurized milk and were less expensive than coffee or tea. By the 1820's, people in the United States were drinking, on the average, the equivalent of 7 gallons (26 liters) of pure alcohol per person each year. This amount of alcohol is in about 70 gallons (260 liters) of beer, 39 gallons (148 liters) of wine, or $15\frac{1}{2}$ gallons (58.7 liters) of distilled liquor.

Some people, including physicians and ministers, became concerned about the extent of alcohol use. They believed that drinking alcohol damaged people's health and moral behavior, and promoted poverty. People concerned about alcohol use urged *temperance*—that is, the reduction or elimination of the use of alcoholic beverages.

At first, supporters of temperance urged drinkers to drink only moderate amounts. But the supporters later became convinced that all alcoholic beverages were addictive. As a result, they tried to end the use of alcohol. In the 1820's and 1830's, the first temperance crusade reduced the average annual intake of pure alcohol per person to about 3 gallons (11 liters). During the 1850's, about a dozen states passed prohibition laws, led by Maine in 1851.

Support for prohibition declined after the Civil War began in 1861. To revive support, people who favored prohibition, often called *drys* or *prohibitionists,* formed a number of organizations to promote liquor reform. In 1869, for example, drys founded the Prohibition Party, which presented prohibitionist candidates for political office. In 1874, a group of Protestant women established the Woman's Christian Temperance Union (WCTU). Drys organized the Anti-Saloon League in 1895.

From about 1900 to 1920, numerous economic, political, and social reforms were carried out in the United States. During this period, many reformers supported national prohibition, and they did so for a variety of reasons. Social reformers blamed alcohol for poverty, health problems, and the neglect by husbands of their wives and children. Political reformers saw saloons as the backbone of corrupt urban political organizations. Employers felt that drunkenness reduced their workers' safety and productivity.

During the early 1900's, some people felt that the large numbers of recent immigrants to the United States would become more "American" if their drinking habits were changed. Many religious denominations taught that drinking alcohol was immoral.

Between 1880 and the beginning of World War I in 1914, many states adopted either statewide prohibition or *local-option laws.* Local-option laws gave individual communities the right to ban the sale of alcohol. In 1913, Congress passed the Webb-Kenyon Act, which forbade the mailing or shipping of liquor into any state that banned such shipments. That same year, drys began calling for a prohibition amendment to the Constitution.



United Press Int.

Government agents seized enormous quantities of illegal beer and liquor during the Prohibition Era. Underworld gangs made millions of dollars from the sale of such alcoholic beverages. Agents dumped much beer into Lake Michigan, *above.*

When the United States entered World War I in 1917, most Americans considered prohibition an appropriate patriotic sacrifice. In December 1917, the U.S. Congress approved the 18th Amendment to the Constitution. This amendment prohibited the manufacture, sale, transportation, import, and export of "intoxicating liquors." It was ratified by the states in January 1919. In October 1919, Congress adopted the Volstead Act. This law provided for the enforcement of the 18th Amendment and defined *intoxicating liquors* as those containing at least 0.5 per cent alcohol. The 18th Amendment went into effect in 1920 with widespread support.

Life during prohibition. Although national prohibition did not eliminate the drinking of alcoholic beverages, it did sharply reduce their use. Purchasing liquor was not only against the law, but it was also very expensive. However, a large minority of Americans continued to drink alcohol. Drinking wine, beer, and other alcoholic beverages had been a traditional part of the cultures of many recent immigrants to the United States, including Irish, Italians, Jews, and Poles. In addition, numerous urban middle- and upper-class Americans considered drinking sophisticated and sociable.

During prohibition, many people made their own beer, wine, or distilled liquor at home illegally. Also, numerous people bought alcoholic drinks in illegal bars called *speakeasies.* Many physicians gave their patients prescriptions for legal "medicinal" wine or liquor.

Bootleggers met much of the demand for illegal alcoholic beverages. Most bootleggers were young immigrant men. The liquor trade was highly profitable, and bootleggers battled each other for control of liquor supplies and markets. Violent gang wars erupted in many large cities, and gang members killed one another at a furious pace. Al Capone of Chicago was probably the era's most famous bootlegger.

During the late 1920's, more than 1 million gallons (3.8 million liters) of liquor was smuggled into the United States each year from Canada. Liquor also was smuggled into the country from ships located just beyond U.S. waters in the Atlantic or Pacific oceans or in the Car-

ibbean Sea. In addition, alcoholic beverages were made from alcohol that was legally produced in the United States for use in manufacturing. Neither federal agents nor state and local officials could stop the widespread violation of national prohibition.

The decline of the prohibition movement. Antiprohibitionists opposed prohibition for a number of reasons. They argued that the ban on alcohol encouraged crime and disrespect for the law. They also claimed that prohibition gave the government too much power over people's personal lives. Recent immigrants to the United States saw prohibition as an attack on their cultural traditions. After the Great Depression began in 1929, many people argued that prohibition took away jobs and deprived the government of badly needed revenues from taxes on liquor.

In the 1932 presidential campaign, the Democratic Party endorsed the repeal of prohibition, and the Democratic presidential candidate, Franklin Delano Roosevelt, won the election by a large margin. In February 1933, Congress proposed the 21st Amendment to the Constitution to repeal the 18th Amendment. The states quickly ratified the 21st Amendment, and national prohibition ended on Dec. 5, 1933.

A few states, mainly ones in the South, retained prohibition until the 1950's or 1960's. In 1966, Mississippi became the last state to repeal statewide prohibition. Since then, most efforts to forbid the use of alcohol by adults have been abandoned. Attention has shifted instead to the treatment of alcoholism and to the solution of other alcohol-related problems.

Prohibition in Canada

A strong temperance movement arose in Canada during the 1840's and 1850's. Many communities adopted local-option laws after the Canada Temperance Act permitted such laws in 1878. In 1898, a national *referendum* (direct vote) showed that a majority of voters outside Quebec favored national prohibition.

After World War I began in 1914, support for prohibition increased in Canada. In 1918, the Canadian government passed a law that banned the manufacture and importation of all alcoholic beverages until a year after the war ended. By 1918, every Canadian province except Quebec had adopted a permanent prohibition law. After World War I ended in 1918, opposition to prohibition increased in Canada. This rising opposition was due in part to a desire to profit from the smuggling of alcoholic beverages to people living under prohibition in the United States. Between 1921 and 1948, all of the Canadian provinces repealed their prohibition laws.

David E. Kyvig

Related articles in *World Book* include:

Chicago (The Roaring Twenties)
Constitution of the U.S. (Amendments 18 and 21)
Illinois (picture: A federal agent breaks barrels)
Nation, Carry
Ness, Eliot
Prohibition Party
Roaring Twenties (Changing attitudes)
Volstead Act
Woman's Christian Temperance Union

Additional resources

Behr, Edward. *Prohibition.* Arcade Pub., 1996.
Hintz, Martin. *Farewell, John Barleycorn: Prohibition in the United States.* Lerner, 1996. Younger readers.

Prohibition Party is a political organization of the United States. Its major purpose is to prevent the use of alcoholic beverages in the country. The party was organized in 1869. It began immediately to present candidates for state and local elections. In 1872, it nominated candidates for president and vice president.

The Prohibition Party reached its greatest strength in 1892, when 271,000 votes were cast for its candidates. The party has declined in strength since then. In 1984, about 4,000 people voted the Prohibition ticket. From 1977 to 1980, the party used the name *National Statesman Party.* The party has worked closely with the American Council on Alcohol Problems, formerly the Anti-Saloon League. Their greatest triumph was passage of the 18th Amendment to the Constitution. This amendment prohibited the production, sale, transportation, import, and export of intoxicants. Donald R. McCoy

See also Prohibition (The movement toward prohibition); American Council on Alcohol Problems.

Projectile. See Ballistics.

Projection screen is a square or rectangular device on which motion pictures or slides are shown. A screen reflects an enlarged image of the projected movie or slide so that many people can view it at one time.

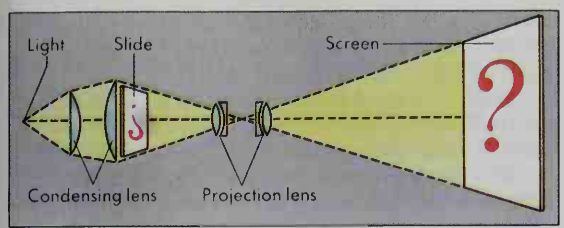
Most projection screens are made of fabric. They vary greatly in size. This article discusses the small portable screens that are used in such places as homes, schools, and libraries. For information on the large, permanently mounted screens that are used in motion-picture theaters, see Motion picture (How motion pictures work [The screen]).

Most portable screens measure from 30 by 40 inches (76 by 100 centimeters) to 60 by 60 inches (150 by 150 centimeters). Screens are classified by their surface. *Glass-beaded* screens have tiny beads on the surface that provide a bright image when viewed from the center of a room. *Lenticular* screens have thin, lens-shaped ridges on the surface and provide a sharp, bright image regardless of viewing angle. *Matte* screens are dull white and provide sharpness and a wide viewing angle. However, they provide less brightness than glass-beaded or lenticular screens. Robert A. Sobieszek

Projector is a device used to show pictures on a screen. One common type is a machine for showing photographic slides. The simplest projector consists of (1) a light, (2) a reflector that focuses light rays, (3) a *condensing* (focusing) lens, and (4) a projection lens.

A powerful light is needed to show pictures on a screen. A projector uses an *incandescent* bulb that glows with heat. Some projectors use bulbs as strong as 1,000 watts. The reflector, located behind the bulb, is a *concave* (inward curving) mirror. Light rays striking it reflect back through the bulb. These rays and rays coming directly from the bulb then enter a thick *plano-convex* lens, which is flat on one side and outward curving on the other. The flat side faces the bulb. Some projectors use a *double condenser,* which consists of two condensing lenses. The light rays entering the condensing lens are bent inward. The rays then pass through a photographic slide placed upside down between the focusing and projection lenses. The projection lens turns the image right side up and enlarges it.

Some kinds of projectors can be used with both film strips and slides. *Overhead projectors* project pictures



WORLD BOOK illustration by Sarah Woodward

A diagram of slide projection, *above,* shows how a projector beams the image of a slide on a screen. Rays from a powerful light are condensed and sent through the transparent slide. *Condensing* lenses focus the rays to provide a clear image. The slide must be put into the projector upside down because the *projection* lenses invert the image on the screen. A slide projector, *below,* can hold more than 80 transparencies in its circular slide tray.


WORLD BOOK photo

above and behind the operator, who can face the audience and use the projector at the same time. Some projectors can project drawings, maps, pages of books, and other material that is opaque—that is, neither transparent nor on transparent film. These projectors are called *opaque projectors.* Robert A. Sobieszek

See also **Filmstrip; Motion picture** (The projector); **Projection screen.**

Prokaryote, *proh KAR ee oht,* also called *moneran* (pronounced *muh NIHR uhn),* is the name of a group of primitive one-celled organisms. Prokaryotes make up the kingdom Prokaryotae. This kingdom consists of blue-green algae, also called *cyanobacteria,* and bacteria. Prokaryotes live alone or in clusters called *colonies.* The individual organisms can be seen only with a microscope, but some colonies are visible with the unaided eye. Prokaryotae is one of the five kingdoms of living things recognized by most scientists. The other kingdoms are Animalia (animals), Fungi (fungi), Plantae (plants), and Protista (protists). Some scientists classify prokaryotes as part of either the protist or plant kingdom.

Most biologists believe prokaryotes are among the oldest types of organisms. Unlike all other living cells, prokaryotes do not have a nucleus surrounded by a membrane. But they do have a nuclear area that contains DNA, the substance that controls heredity. Prokaryotes also lack typical *organelles,* structures that perform functions in other cells (see **Cell** [Inside a living cell]).

Prokaryotes live throughout the world, even where no other life can survive. For example, blue-green algae live in the water of hot springs as well as in frozen wastelands. Free-living bacteria dwell throughout the soil and water, and parasitic species live within nearly all multi-celled plants and animals. Irwin Richard Isquith

See also **Algae; Bacteria; Protist.**

Prokhorov, *PRAW kuh RAWF,* **Alexander Mikhailovich,** *ah lyih KSAN dur myih KY luh vyihch* (1916-2002), was a Russian physicist. In 1953, he and Russian physicist Nikolai Basov stated principles for using the energy of molecules to amplify microwaves. They developed these amplifiers, called *masers,* during the next two years (see **Maser**). For their work, Prokhorov and Basov shared the 1964 Nobel Prize in physics with the American physicist Charles H. Townes.

Prokhorov was born in Atherton, Australia, on July 11, 1916. In 1946, he became a research physicist at the Lebedev Institute of Physics in Moscow. In 1973, he became head of the Institute of General Physics of the Academy of Sciences in Moscow. He died on Jan. 8, 2002. William B. Case

Prokofiev, *praw KAW fyehf,* **Sergei Sergeyevich,** *sehr GAY sehr GEH yuh vihch* (1891-1953), was a major Russian composer. His first symphony, the *Classical* (1918), symphonic fairy tale *Peter and the Wolf* (1936), and cantata *Alexander Nevsky* (1939) are among the most popular classical works. Prokofiev's music has sharp humor, lyric melodies, and percussive use of instruments.

Prokofiev was also a brilliant pianist and often performed his own concertos and solo piano works. His solo piano pieces and nine sonatas became an important part of keyboard music in the first half of the 1900's. Most notable are the *Visions fugitives* (1918) and Piano Sonata No. 7 (1943).

Prokofiev was born on April 23, 1891, in Ukraine. After studying in Russia from 1904 to 1914, he moved to New York City in 1918 and settled in Paris in 1923. Two of his best-known compositions, Piano Concerto No. 3 and the opera *The Love for Three Oranges,* were first performed in Chicago in 1921.

In 1936, Prokofiev settled permanently in Moscow. The major works he composed there include the ballets *Romeo and Juliet* (1938), *Cinderella* (1945), and *The Stone Flower* (1954). Prokofiev composed the first version of his important opera *War and Peace* in 1941 and 1942 and revised it from 1946 to 1952. His Symphony No. 5 (1945) is among the most successful of his seven symphonies. Edward V. Williams

Prologue, *PROH lawg,* is an introduction to a play or other writing. The prologue explains the situation at the start of a play, or it may tell in general terms what the play is about. Sometimes a prologue becomes important and well-known in its own right, as in Geoffrey Chaucer's prologue to his collection of stories, *The Canterbury Tales.* Paul Strohm

Prometheus, *proh MEE thee uhs,* in Greek myths, was a member of the earliest race of gods, called Titans. Prometheus's father was Iapetus, and his mother was either Themis or Clymene.

The god Zeus plotted to destroy humanity by depriving the earth of fire. Prometheus stole fire from the gods and gave it to human beings. Zeus punished him by ordering him bound to a remote peak in the Caucasus Mountains. An eagle came to devour Prometheus's liver every day, and the liver grew back each night. After Prometheus had suffered for many centuries, the hero Hercules killed the eagle and set Prometheus free.

The Greek poet Hesiod described Prometheus as a



Oil painting on canvas (1868) by Gustave Moreau; Musée Gustave Moreau, Paris (Bulloz)

Prometheus was a Greek god who stole fire from the gods and gave it to people. As punishment, he was chained to a rock. Each day, an eagle tore out his liver, which grew back each night.

trickster and a troublemaker. The Greek dramatist Aeschylus presented him as a tragic hero and a champion of humanity in his tragedy *Prometheus Bound.* The German composer Ludwig van Beethoven, the German author Johann Wolfgang von Goethe, and the English poet Percy Bysshe Shelley created works inspired by the Prometheus myth. Justin M. Glenn

Promethium, *pruh MEE thee uhm* (chemical symbol, Pm), is one of the rare-earth metals. Its atomic number is 61, its most stable isotope has a mass number of 145, and its most abundant isotope has a mass number of 147. Its melting point is 1042 °C, and its boiling point is estimated to be about 3000 °C. Three American chemists, J. A. Marinsky, Lawrence E. Glendenin, and Charles D. Coryell, first isolated promethium in 1945. The element exists as radioactive isotopes among the fission products of uranium, thorium, and plutonium. It does not occur naturally. See also **Element, Chemical** (table); **Rare earth.** Larry C. Thompson

Prominence. See **Sun** (Solar activity).

Promontory. See **Cape.**

Pronghorn is a horned and hoofed mammal native to North America. It looks like an antelope, but it is not closely related to antelope or to any other animal with horns or hoofs. The pronghorn is the fastest mammal in the Western Hemisphere. It runs at speeds up to 60 miles (96 kilometers) per hour.

Pronghorns stand 32 to 41 inches (81 to 104 centimeters) high at the shoulder and most weigh 80 to 100 pounds (36 to 45 kilograms). They have large ears, slender legs, and a short tail. Pronghorns vary in color from light tan to reddish-brown, with some white fur on the underparts, rump, face, and throat. Male pronghorns are called *bucks,* and females are called *does.*

Buck pronghorns have black horns with backward curved tips. A hooklike prong sticks out from the front and middle of each horn. The horns grow 10 to 18 inches (25 to 45 centimeters) long. The horns of does are about half that size and usually lack prongs. Many does have no horns at all. Pronghorns are the only animals that shed horns. They shed their horns after the mating season and grow new ones every year. See **Horn.**

Pronghorns are nomadic animals. They roam grasslands from southern Saskatchewan in Canada through the Western United States and into Mexico. In fall and winter, they form large herds, sometimes up to 1,000 individuals. Mating generally occurs from July to October. The young, called *fawns,* are born in spring. A doe will give birth to one, two, or, rarely, three fawns. Fawns reach their mature size at 1 $\frac{1}{2}$ years of age.

Pronghorns eat primarily the leaves of herbs and low shrubs. In winter, they dig through snow for leaves. The chief enemies of pronghorns are coyotes, wolves, and eagles. When a pronghorn senses danger, it bristles the long hairs of its white rump. This action warns other pronghorns of the danger.

Scientists estimate that millions of pronghorns once roamed North America. But by the 1920's, less than 20,000 pronghorns remained. Since then, laws protecting pronghorns have helped increase their population.



Joseph J. Branney, Tom Stack & Assoc.

A male pronghorn, *shown here,* has branchlike horns with hard, black coverings. The animal sheds the coverings each year. Pronghorns roam open grasslands of western North America.

Today, North America has about 600,000 pronghorns.

Scientific classification. The pronghorn is the only member of the family Antilocapridae. It is *Antilocapra americana.*

Valerius Geist

See also **Animal** (picture: Animals of the grasslands).

Pronoun is a part of speech used in place of a noun. Pronouns include such words as *I, you, they, which,* and *that.* Such words provide variety in speaking and writing. The advantage of using pronouns can be seen in the following sentence: *Sally told John that she had met his brother.* Without the pronouns *she* and *his,* this sentence would have to be rephrased *Sally told John that Sally had met John's brother.* The word that a pronoun refers to is called its *antecedent.* In the sentence about Sally and John, the antecedent of *she* is *Sally,* and the antecedent of *he* is *John.*

Pronouns may be classified according to their use into the following types: personal, intensive and reflexive, interrogative, relative, demonstrative, and indefinite. Several pronouns appear in more than one category.

Personal pronouns refer to beings and objects. These pronouns have separate forms that show number, case, person, and gender. *Number* is shown by different forms for singular (*I*) and plural (*we*) pronouns. *Cases* include the subjective case (*he*), objective case (*him*), and possessive case (*his*). *Person* is indicated by separate forms for first person (*I*), second person (*you*), and third person (*she*). *Genders* of a personal pronoun include masculine (*him*), feminine (*her*), and *neuter*—which means neither masculine nor feminine—(*it*).

Personal pronouns must agree with their antecedents in number, person, and gender. However, the case of a pronoun is determined by its use and position in a sentence. In the sentence *Jane liked her teacher,* the pronoun *her* agrees with its antecedent *Jane* in number (singular), person (third), and gender (feminine). But it is in the possessive case, and modifies *teacher.* The table of personal pronouns below lists a complete set of the forms that show number, person, gender, and case.

Where there are two forms of the possessive case listed, the first is used when the noun that the possessive modifies immediately follows: *(That is my book. Where is your book?)* The second is used when there is no noun that immediately follows: *(That is yours. I don't know where mine is.)*

Intensive and reflexive pronouns, such as *myself* and *yourself,* are formed by adding the suffix *-self* or *-selves* to certain forms of the personal pronoun. The suffixes are added to the possessive form of personal pronouns in the first person (*my*) and second person (*your*). The suffixes also combine with the objective form of the third-person pronouns, as in *himself, herself,* and *themselves.* The forms *hisself* and *theirselves* are considered incorrect according to standard grammar.

The intensive pronoun emphasizes the subject of a sentence: *I did it myself.* The reflexive pronoun helps to express an action that reflects upon the subject: *He considered himself lucky to win.* A reflexive pronoun should not be used as a substitute for the subject form of the pronoun. For example, *My husband and I left the house* is correct. *My husband and myself left the house* is incorrect according to standard grammar.

Interrogative pronouns ask questions. The three interrogative pronouns are *who, which,* and *what. Which* and *what* have the same form in all three cases. *Who* has a separate form for each case: *Who came?* (subjective), *Whom did you telephone?* (objective), and *Whose writing is this?* (possessive).

Relative pronouns—*who, which, that,* and *what*—introduce a clause and connect the clause to the word it modifies. The case of a relative pronoun is determined by its function in the clause it introduces:

The boy who is sitting there is my son (subjective).
The boy whom you see is my son (objective).
The boy whose head is turned is my son (possessive).

Many educated speakers accept relative clauses with *who* used in the objective case, except when it is the object of a preceding preposition. Thus:

The boy *who* you see is my son.
The boy *who* you gave the book to is my son.
The boy to *whom* you gave the book is my son.

But not

The boy to *who* you gave the book is my son.

The pronoun *who* refers to people and also sometimes refers to animals and objects, depending on the sense of the sentence. *Which* refers to animals and things. For example, *Alice's essay, which won first prize, was read to the class.* The relative pronoun *that* refers to both beings and things. For example, *Show me the bird that Judy gave you.* The relative pronoun *what* is used in a neuter sense, as in *See what the book says.*

The choice between *that* and *which* may vary with the function of the clause. Clauses introduced by *that* are ordinarily *restrictive*—that is, they provide information essential to the meaning of the sentence. An example is *The car that was totally wrecked was hauled away.* Clauses introduced by *which* are ordinarily *nonrestrictive.* Such clauses add information but are not essential to the meaning of the sentence: *I was able to drive my car, which was only slightly dented.*

Demonstrative pronouns—*this* and *that*—refer emphatically to particular things or actions, as in *This is expensive* or *That is dangerous.* The plural forms of these pronouns are *these* and *those.*

Indefinite pronouns do not indicate a definite gender. Common indefinite pronouns include *all, any, both, each, everybody, few, many, none, one, several,* and *some.* Many of these combine with the suffixes *-one,*

Forms of the personal pronoun

	Singular			Plural		
	Subjective	Possessive	Objective	Subjective	Possessive	Objective
First person	I	my, mine	me	we	our, ours	us
Second person	you	your, yours	you	you	your, yours	you
Third person	he	his	him	they	their, theirs	them
	she	her, hers	her			
	it	its	it			

-body, and *-thing* to form compounds. Some compounds, together with the word *else,* form such pronouns as *someone else* or *everything else.*

Because of changing usage, special difficulty may occur in making verbs agree in number with indefinite pronouns. Problems may also arise in making pronouns agree in number with antecedents that are indefinite pronouns. *Anything, each one, either, neither, nobody, one,* and *something* are singular. For example, *Something is happening outside. Both, few, many,* and *several* are plural. For example, *Many are willing to try.* However, *all, any, each, none,* and *some* may be singular or plural, depending upon the meaning of the sentence. Examples include *All was ready* (singular) and *All were present* (plural). In informal usage, *anybody, anyone, everybody,* and *everyone* are often followed by plural pronouns, even though the verb may be singular. *Everyone was in their place* is informal usage. *Everyone was in his place* is formal.

Growing awareness of the status of women in society has affected usage in this area. According to traditional standards, the proper question, even to an all-woman audience, is: *Would anyone who has lost* his *purse please come to the office?* Many people now use *his* or *her* after indefinite pronouns: (Has anyone lost *his* or *her* pencil?) But not everyone accepts this as proper.

Other usage. Standard usage calls for a subject form of a pronoun after a verb of being: *It was she we elected,* not *It was her we elected.* However, in informal usage, *It's me* and *It's him* can substitute for *It is I* and *It is he.* The selection of the appropriate form often depends on the formality of the occasion.

Expressions that use *than* or *as* often cause confusion about the proper case of the noun. In the sentence *He handles a bicycle better than her,* the objective case of the pronoun *her* may appear to be correct. But it can be seen to be incorrect in terms of standard grammar if the sentence is expanded to read *He handles a bicycle better than she* (*handles a bicycle*). *She* is the subject of the unexpressed verb *handles.* Susan M. Gass

See also **Antecedent; Case; Declension; Gender**.

Pronunciation means saying a word aloud. The degree of distinctness of pronunciation is called *enunciation.* Sometimes words may have more than one acceptable pronunciation. Dictionaries list all the acceptable pronunciations.

The variations in pronunciation are called *dialect differences.* Most languages have them. Dialect differences may come from variations in speakers' geographic location, social status, ethnic background, education, age, and occupation. Most people can understand dialect differences within their native language. But people of different backgrounds may have difficulty understanding each other if their pronunciations differ too greatly.

The people of some countries recognize a certain method of pronunciation as the standard spoken form of their language. In some countries, the standard form is the one spoken in its capital. For example, the people of Japan consider the Japanese spoken in Tokyo to be the standard form of their language. In the United States, one standard pronunciation does not exist. People may use many different pronunciations that are considered correct.

A foreign language can seem hard to pronounce because some of its sounds may not be found in a person's native language. For example, the pronunciation of *r* and *th* sounds in English is hard for native speakers of German, French, and Spanish because the sounds are not used in these languages. The German *oe,* the French *u,* and the Spanish *x* have sounds that are not found in English. People must learn how to place their mouth and tongue to make the new sounds of a foreign language.

Pronunciation problems in English. English words follow a number of complicated pronunciation rules. The majority of words follow these rules. However, English has more irregular pronunciations than many other languages have and many occur among the most frequently used words. Largely for this reason, many people consider English a difficult language to pronounce.

Letters and combinations of letters in English often have more than one pronunciation. One reason for this is that there are only 26 letters to represent about 40 different sounds. For example, the *digraph* (two letters representing one sound) *gh* is silent in *dough,* but sounds like *f* in *cough,* a hard *g* in *ghost,* and a *p* in *hiccough.* In Spanish and Italian, the letter *a* is always pronounced using the broad *a* (*ah,* as in *father*). However, the English words *fat, fate, fare,* and *far* each have a different *a* sound. People must memorize pronunciations that do not follow set rules.

Another reason rules do not apply simply and regularly to the pronunciation of English is that the language has borrowed so much from other languages. Many borrowed words follow the pronunciation rules of the language from which they came rather than the rules for native English words. For example, in most cases an *e* added to the end of a word in English is silent. Its only purpose is to make the vowel before it long. Thus, in *cape* (pronounced *kayp*) the *e* is silent, while the *a* is long. But in the word *cafe* the *e* is pronounced *ay,* while the *a* is short and almost slurred over. *Cafe* is one of the words that we have taken from the French. The final *e* of the French word *café* has an acute accent over it, which gives it the sound of a long *a.* In English, we usually drop the accent marks of other languages but keep much the same pronunciation.

English also has irregular pronunciations because over a period of years the sounds of many words have changed but the spellings have remained the same. In the 1300's, for example, the words *sane* and *sanity* were both pronounced with a short *a* (as in *hat*). The sound of the *a* in *sane* soon changed to a long *a,* but the original spelling had already been established as the standard in printed materials. In another case, the original pronunciation of the digraph *oo* in all words was a long *o* (*oh*). During the 1700's, the pronunciation of *oo* changed. Some of the variations included the *oo* of *food,* the short *u* of *wood,* and the *uh* of *flood.*

English dialects in the United States. There are three major regional dialects in the United States: (1) Northern, also called Eastern or New England; (2) Southern; and (3) Midland, also known as Western or Midwestern. Many local dialects exist within the major ones.

The Northern dialect occurs mainly in New York and New England. Some characteristics of Northern pronunciation include using the broad *a* in words that could use a short *a* (*LAH vuh* for *LA vuh* in the word *lava*), dropping the *r* sound (*cah* for *car*), and using the short *o*

instead of the open *o* (*fahg* for *fawg* in the word *fog*).

The Southern dialect occurs mainly in the Southern States. Some of the features of this dialect include the loss of the *r* sound (*SUH thuhn* for *SUHTH uhrn* in the word *southern*), the use of the broad *a* for a long *i* (*tahm* for *tym* in the word *time*), and the use of a short *i* for an *e* before a nasal sound (*pihn* for *pen*).

The Midland dialect is spoken in Pennsylvania, West Virginia, and most states west of the Appalachian Mountains. This dialect is sometimes considered the standard form of American English because it is spoken over the largest geographic region. Pronunciation characteristics of the Midland dialect include the use of the *r* sound in all word positions, the use of the open *o* for a short *o* (*fawg* for *fahg* in the word *fog*), the use of a long *i* (*tym* in the word *time*).

Since the early 1900's, pronunciation in the United States has become more standardized because people throughout the country have become more and more exposed to each other's speech patterns. This exposure occurs through such means as movies, radio, television, and travel.

Learning pronunciation must start with learning about syllables. Syllables are the natural divisions of a word according to pronunciation. A new syllable is formed around each new vowel sound. Each syllable stands by itself in pronunciation.

Where two vowels are separated by a consonant, the consonant is usually pronounced with the second vowel. Genus is broken up as *ge-nus,* the *n* belonging to the second syllable. The consonant is pronounced with the first vowel when that vowel is short but stressed. Thus, *general* becomes *gen-er-al.*

Two consonants that come together in a word are pronounced separately and belong in separate syllables. Garden is broken up as *gar-den.* Among the consonants which cannot be separated are *ph, th, sh, ch,* and others that are pronounced as a single sound.

Most difficult-to-pronounce article titles in *The World Book Encyclopedia* are followed by their pronunciations. In the pronunciations, the words are divided into syllables and respelled according to the way in which each syllable sounds. Accents are indicated by syllables set in capital letters (main or primary accent) and small capitals (secondary accent). See also *Key to pronunciation* in the front of the "A" volume.

Any long word can be broken up into parts that are already familiar. The word *incantation* is long and looks hard. But it can be broken up into familiar parts—*in-can-ta-tion.* The first part is the same as the first syllable of *invade.* The second part is the same as a tin *can.* The third and fourth parts look like *nation,* beginning with *t* instead of *n.* Thus, *incantation* is pronounced *IHN kan TAY shuhn.* Many persons already know the word *plantation* and find it easy to substitute *inc* for *pl* in learning to say *incantation.*

Marianne Cooley

Related articles. See the *Pronunciation* section of the articles on each letter of the alphabet. For foreign pronunciations, see such language articles as **French language.** See also:

Accent
Consonant
Diphthong
Homonym
Phonetics
Speech therapy
Voice
Vowel

Frequently mispronounced words

Some words that are often pronounced incorrectly are listed in this table. Correct pronunciations are listed for each word. When there are two accepted pronunciations for a word, both are given.

Word	Pronunciation	Word	Pronunciation	Word	Pronunciation
abysmal	*uh BIHZ muhl*	**comptroller**	*kuhn TROH luhr*	**indisputable**	*IHN dihs PYOO tuh buhl*
abyss	*uh BIHS*	**contemplative**	*KAHN tuhm PLAY tihv*		*ihn DIHS pyuh tuh buhl*
accelerate	*ak SEHL uh rayt*		*kuhn TEHM pluh tihv*	**infamous**	*IHN fuh muhs*
access	*AK sehs*	**corps**	*kawr*	**irrelevant**	*ih REHL uh vuhnt*
accurate	*AK yuhr iht*	**crochet**	*kroh SHAY*	**juvenile**	*JOO vuh nuhl*
actual	*AK chu uhl*	**curriculum**	*kuh RIHK yuh luhm*		*JOO vuh nyl*
admirable	*AD muhr uh buhl*	**debenture**	*dih BEHN chuhr*	**lamentable**	*LAM uhn tuh buhl*
advocacy	*AD vuh kuh see*	**decathlon**	*dih KATH lahn*		*luh MEHN tuh buhl*
albino	*al BY noh*	**demonstrative**	*dih MAHN struh tihv*	**larynx**	*LAR ihngks*
albumen	*al BYOO muhn*	**derisive**	*dih RY sihv*	**lichen**	*LY kuhn*
alias	*AY lee uhs*	**deteriorate**	*dih TIHR ee uh rayt*	**magnate**	*MAG nayt*
amalgamate	*uh MAL guh mayt*	**disreputable**	*dihs REHP yuh tuh buhl*	**maintenance**	*MAYN tuh nuhns*
amicable	*AM uh kuh buhl*	**docile**	*DAHS uhl*	**mischievous**	*MIHS chuh vuhs*
anonymity	*AN uh NIHM uh tee*	**drowned**	*drownd*	**nuclear**	*NOO klee uhr*
asterisk	*AS tuhr ihsk*	**dynasty**	*DY nuh stee*		*NYOO klee uhr*
avoirdupois	*AV uhr duh POYZ*	**dysentery**	*DIHS uhn TEHR ee*	**ogre**	*OH guhr*
boatswain	*BOH suhn*	**ecumenical**	*EHK yu MEHN uh kuhl*	**orgy**	*AWR jee*
cache	*kash*	**ensemble**	*ahn SAHM buhl*	**parliament**	*PAHR luh muhnt*
centrifugal	*sehn TRIHF yuh guhl*	**exponent**	*ehk SPOH nuhnt*	**physique**	*fuh ZEEK*
	sehn TRIHF uh guhl	**figure**	*FIHG yuhr*	**picture**	*PIHK chuhr*
chagrin	*shuh GRIHN*	**forbade**	*fuhr BAD*	**preferable**	*PREHF uhr uh buhl*
chamois	*SHAM ee*	**formidable**	*FAWR muh duh buhl*		*PREHF ruh buhl*
charade	*shuh RAYD*	**gesture**	*JEHS chuhr*	**ptomaine**	*TOH mayn*
chasten	*CHAY suhn*	**hearth**	*hahrth*		*toh MAYN*
chastise	*chas TYZ*	**hospitable**	*HAHS pih tuh buhl*	**radiator**	*RAY dee AY tuhr*
chef	*shehf*		*hahs PIHT uh buhl*	**salmon**	*SAM uhn*
clandestine	*klan DEHS tuhn*	**hypocrisy**	*hih PAHK ruh see*	**subtle**	*SUHT uhl*
clientele	*KLY uhn TEHL*	**impotent**	*IHM puh tuhnt*	**suede**	*SWAYD*
column	*KAHL uhm*	**incomparable**	*ihn KAHM puhr uh buhl*	**superfluous**	*su PUR flu uhs*
comparable	*KAHM puhr uh buhl*		*ihn KAHM pruh buhl*	**vehement**	*VEE uh muhnt*

Proofreading means reading printed copy and marking any errors found in it. When a body of type is set, the typesetter prints a *proof* (trial copy) from it. The proofreader then compares the proof with the original manuscript, marking any errors with a set of symbols called *proofreaders' marks.* The proofreader makes one mark in the copy to identify the location of the correction. A corresponding mark is made in the margin to specify the kind of correction needed. The proofreader reads carefully, looking for any misspellings, mistakes, or broken type. The proofreader also reads with an awareness of content, questioning anything inconsistent. When working with publications typeset on desktop computers, the proofreader must also check for correct alignment and positioning of borders and pictures.

After the proof is read, the typesetter makes the corrections and any other changes called for by the author, editor, or client. When no more corrections need to be made, the type is ready for printing.

Proofreaders' marks are shown in the table with this article. Some of the most common include:

The *delete* sign (ℓ) indicates words or letters should be eliminated. The Latin word *stet,* which means *let it stand,* is used to restore words or letters crossed out.

Italic letters (ital) are slanting letters generally used for titles of publications and for stressed words. *Roman* letters (rom) are straight up-and-down. **Boldface** type (bf) is heavier than ordinary type. It is often used for headings.

Lower case (lc) means small letters. Old handset type was kept in sectioned boxes called *cases.* Small letters were kept in the case below capital letters. Almost all type is set by computer today, but capitals and small letters are still called upper case and lower case.

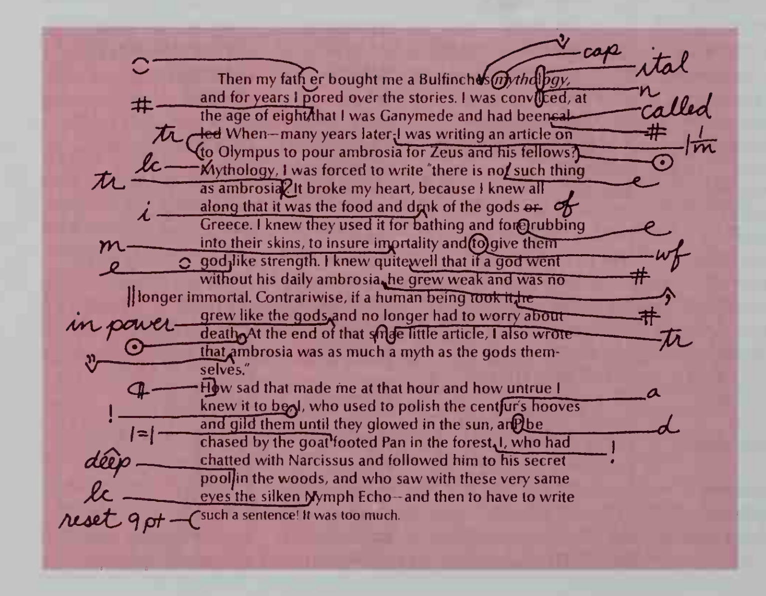
Wrong font (wf) means that the wrong kind of type has been used. A complete set of one design of type is called a *font.*

Accidental errors that occur in typesetting are called *typographical errors* or *typos. Author's alterations,* or *aa's,* are changes, other than corrections, that the author or client has requested.

William C. Esler

Proofreaders' marks

In margin	In copy	Meaning
m	autu^n	Insert
ℓ	autumn,ℓ	Delete
tr	the in autumn	Transpose
sp	for (8) months	Spell out
ital	Autumn's Reveries	Use italics
rom	*Autumn's Reveries*	Use roman type
bf	Autumn's Reveries	Use boldface type
lc	AUTUMN'S REVERIES	Use lower case
caps	autumn's reveries	Use capital letters
sc	Autumn's Reveries	Use small capitals
wf	autumn	Wrong font
⌣	in ⌣the ⌣autumn	Tighten word space
⁐	Au tumn's Reveries	Close up
#	Autumn'sReveries	More space
l/s	AUTUMN	Add space between letters
stet	~~autumn~~	Let it stand
(?)	Mrs. Smithe	Is this correct?
out, see copy	2416^Road	Something left out
⊏	[Autumn's	Move left
⊐	Autumn's]	Move right
¶	autumn. [Until	New paragraph
run on	in the autumn. My reveries	No paragraph break
‖	October November	Align vertically
⊙	autumn^ Until	Insert period
^,^	in autumn^he	Insert comma
∨'∨	Autumns Reveries	Insert apostrophe
∨"∨ ∨"∨	∨Autumn's Reveries∨	Insert quotes
=/	reelect	Insert hyphen
1/m	autumn^the months	Insert em dash
⊙ (colon)	as follows^grain	Insert colon
□	□Autumn's	Indent one em


Then my fath er bought me a Bulfinchs mythology,
and for years I pored over the stories. I was convited, at
the age of eight that I was Ganymede and had been cal-
led When—many years later I was writing an article on
to Olympus to pour ambrosia for Zeus and his fellows
Mythology, I was forced to write "there is no such thing
as ambrosia It broke my heart, because I knew all
along that it was the food and drnk of the gods or
Greece. I knew they used it for bathing and for rubbing
into their skins, to insure imortality and to give them
god like strength. I knew quitewell that if a god went
without his daily ambrosia he grew weak and was no
longer immortal. Contrariwise, if a human being took it he
grew like the gods and no longer had to worry about
death At the end of that smae little article, I also wrote
that ambrosia was as much a myth as the gods them-
selves."
How sad that made me at that hour and how untrue I
knew it to be I, who used to polish the centurs hooves
and gild them until they glowed in the sun, and be
chased by the goat footed Pan in the forest I, who had
chatted with Narcissus and followed him to his secret
pool in the woods, and who saw with these very same
eyes the silken Nymph Echo—and then to have to write
such a sentence! It was too much.

Then my father bought me a Bulfinch's *Mythology,* and for years I pored over the stories. I was convinced, at the age of eight, that I was Ganymede and had been called to Olympus to pour ambrosia for Zeus and his fellows. When—many years later—I was writing an article on mythology, I was forced to write "there is no such thing as ambrosia." It broke my heart, because I knew all along that it was the food and drink of the gods of Greece. I knew they used it for bathing and for rubbing into their skins, to insure immortality and to give them godlike strength. I knew quite well that if a god went without his daily ambrosia, he grew weak and was no longer immortal. Contrariwise, if a human being took it, he grew like the gods in power and no longer had to worry about death. At the end of that same little article, I also wrote that "ambrosia was as much a myth as the gods themselves."

How sad that made me at that hour and how untrue I knew it to be! I, who used to polish the centaur's hooves and gild them until they glowed in the sun, and be chased by the goat-footed Pan in the forest! I, who had chatted with Narcissus and followed him to his secret pool deep in the woods, and who saw with these very same eyes the silken nymph Echo—and then to have to write such a sentence! It was too much.

Proofreaders' marks on the printed proof show corrections that must be made in typeset matter, *left.* The corrected version, or revised proof, is shown above.


U.S. Army Center of Military History


National Archives, Collection U.S. Office of War Information

Two propaganda versions of Adolf Hitler show the German dictator from opposite viewpoints. A pro-Hitler poster, *left,* portrays him as a heroic warrior crowned with a halo of light. An anti-Hitler cartoon, *right,* pictures him as a ridiculous, loudmouthed tyrant.

Propaganda is one-sided communication designed to influence people's thinking and actions. A television commercial or a poster urging people to vote for a political candidate might be propaganda, depending on its method of persuasion.

Propaganda differs from education in democratic societies. But education in a dictatorship can involve teaching children and youth by techniques that could be classified as propaganda. Educators in democratic societies teach people how to think, but propagandists tell them what to think. Most educators are willing to change their opinions on the basis of new evidence, but propagandists ignore evidence that contradicts them. Educators present all sides of an issue and encourage debate. Propagandists build the strongest possible case for their views and discourage discussion.

The intention of the communicator to influence or deceive is an important issue in identifying propaganda. However, experts disagree about what is propaganda and what is not, and whether propaganda differs from other forms of persuasion, such as advertising and political campaigning. Some look upon all slanted communication as propaganda. Others believe that the method of persuasion determines whether a message is propaganda. For example, the majority of advertisers and political campaigners function openly and state their purposes truthfully. Other advertisers and political campaigners present any combination of truths, half-truths, lies, and distortions that they think will most effectively influence their audience. Some experts say all these people are propagandists. Others regard only the second group as propagandists.

Some people consider propaganda neither good nor bad. For example, many favor the use of propaganda to raise money for charity. Other individuals argue that the public needs reliable information to make wise decisions, and that propaganda blocks the spreading of such information. They also fear that propaganda deadens people's power of reasoning. The results of some propaganda may be short term and relatively insignificant, such as the purchase of a product. Other types of propaganda can have more serious results.

The greatest use of propaganda occurs during wartime. At such times, government propaganda campaigns urge people to save resources, volunteer for military service, support the war effort, and make sacrifices necessary for victory. *Psychological warfare* is a type of propaganda that aims to weaken the enemy's will to fight or belief in their government. A related technique, called *brainwashing,* is used against prisoners. It combines political propaganda with harsh treatment to reduce a prisoner's resistance.

Much wartime propaganda is called *covert* (secret) *propaganda* because it comes from hidden sources. For example, a propagandist might try to discourage enemy troops by sending them counterfeit newspapers reporting huge losses among their forces. Some covert propaganda is spread by people in a country who secretly support its enemies. A group of such people is called a *fifth column.* The opposite of covert propaganda is called *overt* (open) *propaganda,* which comes from known sources.

How propaganda works

Propaganda appeals to its audience in three ways. (1) It calls for an action or opinion that it makes seem wise and reasonable. (2) It suggests that the action or opinion is moral and right. (3) It provides a pleasant feeling, such as a sense of importance or of belonging.

Many propaganda methods are common-sense techniques that resemble those of persuasive speaking. These techniques include gaining people's trust, simplicity and repetition, and the use of symbols. However, propagandists often use such underhanded methods as distortion, concealment, and lying. In nations ruled by dictators, governments increase the effectiveness of their propaganda by using censorship.

Gaining people's trust. Above all, propagandists must be believable, and their audience must consider them reliable authorities. One way to gain an audience's trust is to report unfavorable news that the audience knows or will discover. During World War II (1939-1945), the British Broadcasting Corporation (BBC) made propaganda broadcasts to Europe. The BBC began many

newscasts with a report of British defeats and losses. This practice helped give the BBC a worldwide reputation for truthfulness.

Another way to gain people's trust is to agree with their existing opinions. Scientists have found that people place most trust in speakers and writers whose ideas are similar to their own. As a result, propaganda is most successful if much of it agrees with what people already believe and if only a little of it is new.

Simplicity and repetition. Propaganda must be easy to understand and to remember. As far as possible, propagandists make their appeals in simple, catchy slogans that they repeat over and over. The Nazi dictator Adolf Hitler wrote: "The intelligence of the masses is small. Their forgetfulness is great. They must be told the same thing a thousand times."

The use of symbols involves words and illustrations that bring strong responses from people. Individuals react not only to the actual meaning of words and the actual content of pictures but also to the feelings aroused by such symbols. For example, nearly all cultures have favorable reactions to a picture of a mother and baby or to such words as *homeland* and *justice*. Propagandists try to create an association in people's minds between such symbols and the messages they are trying to spread. Powerful negative images are frequently used to increase prejudice, hostility, and hatred toward the desired targets of propaganda.

American Cancer Society

Propaganda uses emotions rather than logic to persuade its audience. This antismoking poster tries to create an association in people's minds between smoking and unattractiveness.

Distortion and concealment. Propagandists deliberately exaggerate the importance of some facts and twist the meaning of others. They try to conceal facts that might prevent the response they seek from people. They also try to shift attention away from embarrassing facts that cannot be hidden.

Lying. Deliberate lying is relatively rare as a propaganda technique because propagandists fear their lies might be discovered and they might lose their audience's trust. Propaganda usually includes some accurate information. But some propagandists readily lie if they think they can deceive their audience. Propagandists may believe in their causes, but their chief goal is to shape and control the public's beliefs and actions.

Censorship is most common where the government controls the newspapers, television, and other means of communication. It increases the effectiveness of propaganda because the government can silence people who contradict its official views. See **Censorship**.

Who uses propaganda?

Propaganda comes from many sources. Three of the most important ones are (1) governments, (2) organizations, and (3) businesses.

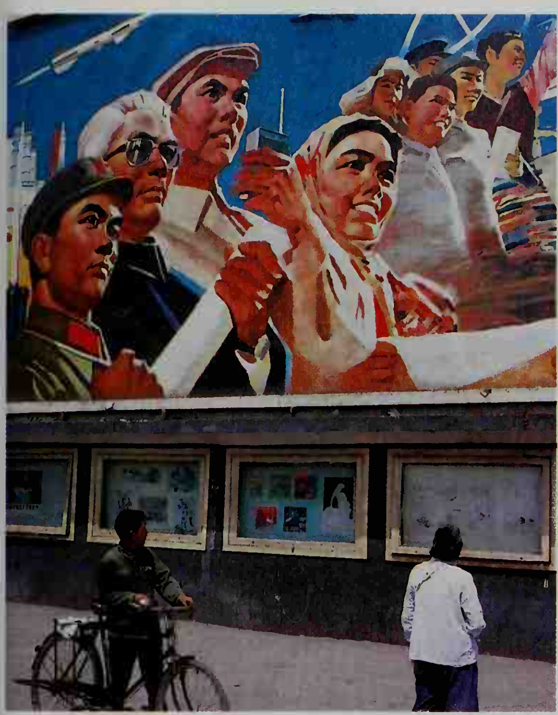
Governments. Nearly all governments, including democratic ones, use propaganda to win support from other nations. Governments also sponsor propaganda and information programs to promote desired behavior among their own citizens. For example, government propaganda might urge people to support certain policies or to oppose foreign political systems.

Organizations represent members of various professions, religions, and many other fields. During election campaigns, many organizations distribute propaganda that supports candidates who agree with their views. Between elections, organizations may also use propaganda to influence public opinion. Many groups employ people called *lobbyists,* who work to persuade legislators to support their programs. A group that tries to further its own interests by exerting pressure on legislators or other officials is often called a *pressure group.* Group members outline their goals on such controversial topics as abortion, busing, civil rights, the environment, foreign policy issues, gun control, and nuclear energy.

Businesses often use propaganda in their advertising. For example, a mouthwash commercial on television might be aimed at people's desire to be attractive and popular. Advertising agencies employ psychologists and other social scientists to study why people buy certain products. They try to determine what slogans will lead to purchases. Many large businesses also have public relations departments that use propaganda to spread favorable opinions of company policies.

History

Today, the word *propaganda* suggests shady or underhanded activity, but that was not its original meaning. The term came from the Latin name of a group of Roman Catholic cardinals, the *Congregatio de Propaganda Fide* (Congregation for the Propagation of the Faith). Pope Gregory XV established the committee—called the *propaganda* for short—in 1622 to supervise missionaries. Gradually, the word came to mean any ef-



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Governments use propaganda to promote desired behavior among their citizens. This Chinese poster encourages people to adopt modern attitudes in industry and in education.

fort to spread a belief. It acquired its present meaning after World War I (1914-1918), when writers exposed the dishonest but effective techniques that propagandists had used during the war.

Propaganda as it is used today began in the early 1900's. V. I. Lenin, who led the revolution that established Communist control of Russia, emphasized the importance of propaganda. He distinguished between two types of persuasion—propaganda and agitation. Lenin regarded propaganda as the use of historical and scientific arguments to convince the well-educated minority. He defined agitation as the use of half-truths and slogans to arouse the masses, whom he considered incapable of understanding complicated ideas. Traditionally, each Communist Party has included a unit that specializes in *agitprop*—agitation and propaganda.

During World War I, the Allies—including Britain, France, Russia, and the United States—fought the Central Powers, led by Germany. The warring nations conducted widespread propaganda operations. The major U.S. propaganda effort was handled by an agency called the Committee on Public Information. The committee distributed more than 100 million posters and publications designed to increase support for the war.

Between the wars, several famous dictators used propaganda to help them achieve power. In 1922, Benito Mussolini established a Fascist dictatorship in Italy. Fascist propaganda promised to restore Italy to the glory of ancient Rome. Joseph Stalin, who became dictator of the Soviet Union by the late 1920's, used propaganda and terrorism to crush all opposition. The Soviet Union had been formed under Russia's leadership in 1922. In 1933, Adolf Hitler set up his Nazi dictatorship in Germany. The Nazis' effective use of education, motion pictures, press, and radio to shape opinion and behavior remains one of the most famous examples of propaganda.

During World War II, Germany, Italy, and Japan fought Britain, the Soviet Union, the United States, and the other Allies. All of the major powers spread far-reaching propaganda. The United States had two primary propaganda agencies. The Office of War Information handled overt propaganda, and the Office of Strategic Services (OSS) carried on covert operations.

After World War II ended in 1945, the Cold War began. The Communist nations, led by the Soviet Union, and the non-Communist nations, led by the United States, used a variety of propaganda techniques to influence world opinion, as well as their own citizens.

In 1953, the U.S. government created the U.S. Information Agency (USIA) to create support of its foreign policy. The Voice of America, the radio division of the USIA, broadcast entertainment, news, and propaganda throughout the world. The government used the Central Intelligence Agency (CIA) to spread covert propaganda against governments unfriendly to the United States. These governments included those of the Soviet Union and the Communist countries of Eastern Europe. The CIA also provided funds to establish radio networks called Radio Free Europe and Radio Liberty, which broadcast to Communist countries.

Since 1960. In the early 1960's, China began to challenge the Soviet Union for leadership of the Communist world, and a bitter propaganda struggle developed between them. Each accused the other of betraying Communism. After 1970, several Communist and non-Communist nations at times enjoyed friendlier relations and altered their propaganda operations against one another. The United States and the Soviet Union enjoyed such relations in the early 1970's and beginning again in the late 1980's. In 1989 and the early 1990's, Communists lost control of the governments of many Eastern European countries and the Soviet Union, and in 1991 the Soviet Union broke up into a number of independent states. However, Radio Free Europe continued to broadcast to Eastern Europe, and Radio Liberty kept transmitting to former Soviet areas. In addition, Voice of America continued to broadcast throughout the world. Radio Free Asia, another U.S. service, began broadcasting in 1996. Its programs are transmitted to China, North Korea, and Southeast Asia. Propaganda is still used today in many nations. Taylor Stults

Related articles in *World Book* include:

Advertising
Brainwashing
Fifth column
Goebbels, Joseph
Lobbying
Psychological warfare
Public opinion
Public relations
Radio Free Europe/Radio Liberty
Voice of America
World War II (Propaganda)

Additional resources

Chomsky, Noam. *Media Control: The Spectacular Achievements of Propaganda.* Seven Stories, 1997.

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Different kinds of propellers produce the thrust that moves ships through the water and airplanes through the air. A typical ship propeller, *above left,* has three or more broad blades. Most airplane propellers have two or more narrow blades.

Propane. See **Butane and propane.**

Propeller is a device for producing motion that has blades mounted on a power-driven shaft. A propeller changes an engine's power into forward thrust. The best-known types of propellers are those that drive ships and airplanes. A propeller's rotating blades produce a kind of force known as *aerodynamic lift* that pushes or pulls an aircraft through the air and a ship through the water (see **Aerodynamics** [Lift]). Airplane propellers and marine propellers work in much the same way, but they produce motion in different fluids.

The first screw propeller was developed by John Fitch in 1796. His propeller was in the form of a spiral around a cylindrical rod. John Ericsson, a Swedish-American inventor, developed the first successful propeller with blades in 1836 (see **Ericsson, John**).

Airplane propellers are also known as *airscrews.* They have two or more blades. The cross sections of the blade are airfoil sections similar to those used in airplane wings. The *pitch* is the angle between the cross section of the blade and the plane through which the propeller rotates. Propeller blades are twisted, and so the pitch changes along the length of the blade. As a result, the propeller blade meets the air at the angle that gives it the greatest efficiency. The efficiency of a propeller drops off and the noise it makes increases rapidly as the speed of the tips of its blades increases beyond the speed of sound.

A fixed-pitch propeller is one in which the angle at which the blades are set is fixed. Such propellers are efficient only at one speed of flight and for a definite power output. They usually are used on small aircraft.

A constant-speed propeller has variable pitch. The angle of the blades adjusts continuously to provide the most efficient operation at every flight speed. The propeller automatically turns the same number of revolutions per minute under all conditions of flight. It does not gain speed in dives or lose speed in climbs. This propeller is used on transport aircraft.

Many constant-speed propellers have special features that are used in emergency situations. For example, a *feathering* device enables the pilot to increase the blade angle enough to streamline the blades with the engine stopped. In case of an engine failure, the pilot can *feather,* or rotate, the blades so that their leading and trailing edges parallel the path of flight. This action decreases the propeller's air resistance and prevents possible damage to the engine.

Another feature of many constant-speed propellers is *reversible-pitch.* On such propellers, the blades can be set at a negative pitch so that the direction of the thrust is reversed. This acts as a brake and reduces the landing run on the ground. Reversible-pitch is of great value for large airplanes, particularly when runways are covered with ice or snow, making the wheel brakes ineffective.

Marine propellers range in diameter from 10 inches (25 centimeters) for small boats to more than 25 feet (7.5 meters) for large tankers. They are usually made of manganese and bronze.

Battleships and large tankers may have propellers with five or six blades, while smaller ships use three- or four-bladed propellers. Propellers on single-screw ships turn to the right, or clockwise, when viewed from the stern when the ship is going ahead. Twin-screw vessels usually have out-turning propellers. The starboard screw turns clockwise, and the port screw, counterclockwise, for ahead motion. Twin-screw ships are easily steered by reversing one of the engines while the other goes full ahead. Destroyers and other small craft can make sharp turns in this way. Conventional propellers are less effective at high speeds because of *cavitation,* the formation of a vacuum as the propeller turns. A propeller called a *supercavitating* propeller is designed so that cavitation increases the effectiveness of the propeller at high speeds. Allen Plotkin

See also **Airplane** (Propellers); **Screw; Ship** (The chief parts of a ship).

Property, in law, means the rights people have in things. Such rights are often called *ownership.* Property may refer to a car, a farm, a watch, or anything else that

is owned. Property also may refer to interests in things that are owned by more than one person. Such interests include stock in a corporation. The corporation owns the machinery, the raw materials, and the finished products. But the stockholder is entitled to share in its profits as an owner of the corporation. Property may be classified in two ways. *Real property* includes interests in land and the things permanently attached to it, such as buildings and trees. All other things are *personal property.*

Various types of interests in property exist in American and English law. For example, an owner of land has an *absolute* property interest if the owner is the only person with an interest in the land. The owner may allow another person to occupy it as a farm for 10 years. During that time, the owner is entitled to be paid for the use of the land but cannot use it. In this case, the owner has a *qualified nonpossessory* property interest—that is, a right to regain full ownership and possession of the land in the future. The farmer is entitled to possess the land and can prevent anyone from interfering with the use of the property. The farmer has a *qualified possessory* interest. During the 10 years, the farmer can provide for an *easement* (limited right of use) by permitting a neighbor to cross the land to reach a road or other piece of land. The easement gives the neighbor a *qualified nonpossessory* interest.

Property interests may be acquired in several ways. People may buy property, find it, or receive it as a gift. They also may get property by a court order, as in the distribution of the estate of a person who has died without leaving a will. Joel C. Dobris

Related articles in *World Book* include:

Abandonment	Domesday Book	Property tax
Appraisal	Eminent domain	Proudhon, Pierre
Assessment	Estate	Public domain
Assignment	Fee	Real estate
Attachment	Intellectual property	Receiver
Attainder		Title
Capital	Joint tenancy	Trust fund
Deed	Mortgage	Vandalism
Depreciation	Personal property	

Property tax is a tax collected from the owners of buildings, land, and other taxable property, including business equipment and inventory. Some governments also collect taxes from the owners of such property as stocks and bonds.

Property taxes provide much of the income of cities, counties, towns, and school districts in the United States, Canada, and many other countries. Local governments depend on these taxes to help finance education, police and fire protection, street repair, and other services. Some state and provincial governments also collect property taxes.

The government of a community sets an annual tax rate to determine each property owner's tax bill. This rate is a percentage of the *assessed* (estimated) value of the property. In many cases, the assessed worth is less than the property's market value. For example, a house might have a market value of $100,000 but be assessed at only $60,000. If the tax rate were 5 percent, the annual property tax would be $3,000. See **Assessment.**

The major problem with property taxation is that much property is not assessed fairly and uniformly. Another drawback is that assessments and rates change too slowly to keep up with rising prices. In countries with high rates of inflation, assessments have often fallen far behind market values. Some people oppose property taxes because they believe property ownership is a poor measurement of ability to pay. But others argue that property owners are the people who benefit most from community services, and so they should pay more for these services. In 1978, California voters approved a measure, called Proposition 13, that reduced state property taxes. Several other states soon enacted similar laws. Vito Tanzi

See also **Education** (How should education be financed?); **Personal property.**

Prophet, in religion, is the title given to a person who claims to communicate God's will to others. The life and teachings of prophets have provided the basis for some religions. For example, Islam is based on the life and teachings of the Prophet Muhammad. Similarly, Joseph Smith, the founder of the Mormon Church, is considered a prophet by his followers. The most famous prophets lived in ancient Israel during Biblical times.

There were two types of prophets in ancient Israel—*professional prophets* and *classical prophets.* Professional prophets earned a living by trying to determine for their clients the nature of God's will in regard to specific issues and problems. Classical prophets did not choose to become prophets. They believed God called them to proclaim His message to the people of Israel. The classical prophets are also called *literary prophets* because their words are recorded in Biblical books. The magnificent poetry of many of their sayings represents a high point in Hebrew literature.

Classical prophets introduced the idea that God ruled over all nations, not just Israel. These prophets spoke directly to the major leaders of their time. They urged the people to remain faithful to God and to act justly with each other. Carol L. Meyers

See also **Bible** (Books of the Hebrew Bible) and the list of *Related articles* at the end of the **Bible** article.

Prophylaxis, *PROH fuh LAK sihs,* means any treatment that protects a person from a disease. Prophylaxis is also called *preventive* treatment. Treatment is called *corrective* or *curative* when the patient already has a disease or unhealthful condition.

Preventive measures have been very important in improving health and prolonging life. Methods pioneered by Edward Jenner, Robert Koch, Louis Pasteur, and others proved it is possible to strengthen the body so it will be immune to certain diseases through the use of vaccines. *Collective prophylaxis* is preventive medicine in the field of public health. For example, sanitation and widespread immunization help protect communities from many diseases. Alan R. Hinman

See also **Disease** (Preventing disease); **Immunization.**

Proportion is a relationship of equivalence between two ratios. For example, the equation $\frac{a}{b} = \frac{c}{d}$ is a proportion. The equation states that a is related to b in the same way that c is related to d. It can also be written as $a{:}b = c{:}d$. Equivalent ratios are said to be *in proportion.*

In the proportion $\frac{a}{b} = \frac{c}{d}$, a is called the first term; b, the second term; c, the third term; and d, the fourth term. The first and fourth terms are called the *extremes* of the proportion, and the second and third terms, the *means.* For all proportions, the product of the means equals the product of the extremes. For the proportion

$\frac{a}{b} = \frac{c}{d}$, it is therefore true that $a \times d = b \times c$. This property of proportions provides a formal way of finding an unknown term of a proportion when the three remaining terms are known. For example, the unknown term n in the proportion $\frac{9}{3} = \frac{15}{n}$ can be determined by solving the equation $9 \times n = 3 \times 15$:

$$9n = 3 \times 15$$
$$9n = 45$$
$$n = 5$$

When two ratios are in proportion, the terms of one ratio can be multiplied by a certain number to produce the terms of the other ratio. In the proportion $\frac{2}{4} = \frac{4}{8}$, for example, both terms of the ratio $\frac{2}{4}$ can be multiplied by 2 to produce $\frac{4}{8}$.

All ratios considered as numbers that are in proportion to one another equal the same number. This number is called a *constant of proportionality.* For example, the ratio of the circumference *(c)* to the diameter *(d)* of any circle is in proportion to the same ratio for any other circle. All such ratios ($\frac{c}{d}$) are equal to 3.14159. This constant of proportionality is known as *pi* (π).

The idea of proportion is the basis for many laws of astronomy, biology, chemistry, and physics. Many of these laws contain famous constants of proportionality. The idea of proportion is also used in the social sciences and the arts. Architects use it in designing scale models and drawing building plans. Thomas E. Kieren

Proportional representation is a system of electing members of a legislature. It is designed to give a political party a share of the seats in the legislature in proportion to its share of the total vote cast in an election. It also offers opportunities for candidates of minority parties to be elected. Proportional representation has three basic features: (1) three or more legislators are chosen from each district at the same time; (2) the ballots are counted in a special way to give each political party its share of the vote; and (3) there are usually more than two active parties. These elements are present in both the *List System* and the *Hare System.*

The List System. Each political party offers a list of candidates for the legislature, and voters mark their ballot for the party they choose, not the individual candidates. If a party wins 40 percent of the vote, it receives 40 percent of the available seats in the legislature. In a campaign to fill 100 seats, the first 40 candidates on the party's list would be elected. If another party wins 20 percent of the vote, its top 20 candidates receive seats in the legislature. The Netherlands, Belgium, and Israel are among the countries using this system.

The Hare System, or single transferable vote, is much more complicated. Voters number the candidates on their ballot in the order of their choice. After counting the total number of ballots, election officials determine a mathematical *election quota,* the minimum needed for election. Then they count all the first choices. A candidate who wins the quota of first choices is declared elected. All of this candidate's ballots above the quota are redistributed to the candidates chosen second by the voters. Next, the candidate with the fewest number of ballots is eliminated. This person's ballots are redistributed to the second-choice candidates listed. If the second-choice candidate has already been elected, the ballot is passed on to the third choice, and so on. This process continues until enough candidates have reached the election quota to fill all the seats. An English lawyer, Thomas Hare, described the system in 1859. The Republic of Ireland has used it since 1920.

Robert Agranoff

Propulsion, Jet. See Jet propulsion.

Prose is the language of everyday speech and writing. It is also one of the two major forms of literary expression. The other is poetry. Letters and newspaper and magazine articles are written in prose. So are biographies, essays, histories, novels, and a majority of plays. Most prose, unlike much poetry, has no regular meter. Prose also lacks rhyme, which is a feature of many poems. However, prose writers often use such poetic devices as alliteration and repetition, and some writers compose highly rhythmical prose. In many cases, it is difficult for a reader to clearly distinguish between prose and poetry.

Prose styles range from simple to complex. For hundreds of years, writers and literary critics have argued about the ideal prose style. For example, Francis Bacon, an English author of the early 1600's, favored a simple, clear, straightforward style of writing. He composed short sentences with few adjectives. On the other hand, Sir Thomas Browne, an English author of the mid-1600's, preferred to use a richer, more elegant prose style. He wrote graceful, rhythmic sentences that sounded poetic.

The King James Version of the Bible, published in 1611, combined certain features of both styles of prose. Its elegant yet natural style greatly impressed many readers. Since its publication, the King James Version has been the single most important influence on English prose writing.

During the 1900's, many writers of English prose favored a brisk, clear style and tried to copy the rhythm and vocabulary of ordinary speech. This conversational style is exemplified by the works of Ernest Hemingway, Gertrude Stein, William Carlos Williams, and Virginia Woolf. William H. Epstein

Related articles in *World Book* include:

Autobiography	Drama	Fiction
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Proserpina. See Persephone.

Proslavery movement was an attempt by Southerners to justify and expand slavery in America between the 1830's and 1860. Southerners argued that both the Bible and history endorsed slavery, that *emancipation* (freeing the slaves) was impractical, and that slavery was necessary to save the Southern economy. John C. Calhoun and other well-known Americans defended slavery. They called it "the law of nature," "a positive good," and "the greatest and most admirable agent of civilization."

The proslavery movement wanted to extend slavery into the Western territories and wanted to add Texas to the Union. Former President John Quincy Adams called the Mexican War (1846-1848) "a slave-power conspiracy," a means to gain more slave territory. Abolitionists condemned efforts to acquire Cuba as an attempt to add another slave state. In the late 1850's, some Southerners wanted the foreign slave trade reopened. The Civil War destroyed slavery in the nation and ended the proslavery movement. James M. McPherson

See also **Civil War** (The conflict over slavery); **Slavery** (Slavery in the United States).

Prospecting is the process of searching for valuable deposits of minerals or fuels. Early prospectors in the United States were lured by the promise of gold, oil, and other valuable minerals. Gold prospectors explored canyons and mountains with picks, shovels, gold-pans, and other simple equipment. Petroleum prospectors drilled shallow holes looking for oil reservoirs. Most early prospectors had no scientific training. Modern prospectors, sometimes called *explorationists,* are scientists with training in geology, geophysics, and mining.

Prospectors today mainly search for deeply buried deposits, because most minerals that were near the surface have already been discovered. They usually begin by examining areas of known deposits to determine the conditions under which valuable minerals or fuels occur. Using satellite photographs of Earth's surface, prospectors choose a site whose surface conditions indicate the likely presence of minerals underground.

To learn what lies underground, prospectors have the site's topsoil, water, and plants analyzed for *trace elements.* Trace elements are tiny amounts of certain chemical elements. Their presence may indicate deposits of a certain mineral below the surface.

Prospectors use several instruments in their search for deposits. Gravimeters, or gravity meters, measure the pull of gravity at the earth's surface. Metals and other dense rocks increase gravitational pull while light, porous minerals decrease it. Magnetometers record changes in the earth's magnetic field. Magnetometers help prospectors find petroleum, certain iron ores, and other minerals with magnetic properties. Prospectors use lamps that give off ultraviolet light to find fluorescent minerals. When illuminated with this light, these minerals glow with definite colors. Geiger counters and scintillation counters measure radiation. Prospectors use them to find radioactive minerals such as uranium and thorium. Seismographs measure movements of rock, such as shaking produced by earthquakes or vibrations created by underground sound waves. In the *seismic method* of exploration, prospectors use explosives to create sound waves. By studying the speed and direction of waves reflected by buried rock layers, prospectors can determine the structure of the layers.

Once prospectors have determined that a site contains valuable minerals, they drill deep holes at the site to obtain rock cores or fragments. These samples help the prospectors determine the size, value, and exact location of the deposit. William Hustrulid

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Petroleum (Exploring for petroleum)
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Uranium (Locating uranium)

Prosser, Gabriel. See Gabriel.

Prostaglandin, *PRAHS tuh GLAN duhn,* is the name of a group of important chemical compounds. They are modified versions of fatty acids found throughout the bodies of human beings and all other animals. They help control stomach acid production, regulate blood pressure and body temperature, and alter muscles of the bronchi, intestines, uterus, and other body organs. Prostaglandins also play a major role in reproduction.

Scientists believe prostaglandins serve as part of the body's control system. Hormones, another important group of chemical substances, carry messages from the glands to various organs in the body (see Hormone). Prostaglandins, on the other hand, act locally between cells. They have a role in protecting the body from certain unhealthful conditions. For example, prostaglandins made in the stomach prevent ulcers. However, when a person's physical condition is impaired, prostaglandins can make things worse if produced in large amounts. This sometimes occurs when a person is in shock.

Prostaglandins were first discovered in the early 1930's. But until the late 1960's, scientists did not learn how to produce them from common materials. Since then, researchers have found how to make prostaglandin *analogues* (stable, long-acting versions of prostaglandins) and *antagonists* (chemicals that block the action of prostaglandins). They also have found that aspirin works by preventing the formation of prostaglandins from certain fatty acids.

Since the early 1970's, prostaglandin drugs have been used to perform abortions or to bring on childbirth. In addition, experiments show that prostaglandins—and their analogues and antagonists—might be used to treat many kinds of disorders. Such disorders include arthritis, asthma, blocked nasal passages, high blood pressure, and ulcers. Kermit L. Carraway

Prostate cancer, *PRAHS tayt,* is an uncontrolled division of cells in the prostate gland, a walnut-sized internal organ of the male reproductive system. In the United States, prostate cancer kills more men than any other cancer except lung cancer. African American men have the highest rate of prostate cancer in the world. Individuals have an increased risk of prostate cancer if other men in their families have also had the disease.

A cancerous prostate gland may become enlarged and press on the *urethra,* the tube through which urine leaves the body. The expanding gland may also put pressure on the bladder. Many prostate cancer patients consult a doctor because this pressure causes frequent urination or difficulty passing urine.

Doctors must test to determine if these symptoms are due to cancer or to noncancerous enlargement of the prostate, another common condition. The first such test is often a digital rectal examination, in which a doctor feels the prostate gland directly by inserting a finger, covered with a lubricated glove, into the patient's rectum. A lump or an area of hardness may indicate cancer. Another means of diagnosing prostate cancer is a blood test that measures a protein called *prostate-specific antigen* (PSA). Elevated levels of PSA, which is produced only in the prostate gland, may indicate cancer.

A suspicious digital exam or PSA test is often followed by an *ultrasound* examination, which uses sound waves to create a detailed image of the prostate. This image aids a doctor in obtaining small surgical samples of tissue from the gland. If the tissue is cancerous, more tests are needed to determine if the cancer is confined to the prostate or has spread elsewhere in the body.

Doctors can often cure cancer that remains confined to the prostate by radiation therapy or by surgical removal of the gland. Both treatments may interfere with a man's ability to have sexual relations or may cause *urinary incontinence* (inability to hold back urine). Surgeons have developed an operation that may avoid sexual problems by preserving nerves important in sexual

functioning. Doctors extend the lives of patients whose cancer has spread beyond the prostate gland with treatments that reduce levels of male hormones. Prostate cancer cells need male hormones to survive and grow.

Doctors recommend that middle-aged men have an annual digital rectal examination to detect any prostate cancer before it causes symptoms. Many doctors also recommend an annual PSA test, which can detect small tumors before they can be felt. Some doctors fear that this use of the PSA test will find some slow-growing cancers that would never become life-threatening. Treating such cancers may subject patients to the risks of unnecessary surgery or other procedures. But doctors cannot yet predict which tumors will become life-threatening. Marc B. Garnick

See also **Cancer; Prostate gland.**

Prostate gland, *PRAHS tayt,* is an organ of the male reproductive system. It produces a thick whitish fluid that helps transport sperm. All male mammals have some form of prostate gland. In men, this gland sits just below the urinary bladder and directly in front of the rectum. The *urethra,* the tube through which urine leaves the body, passes through the prostate. The gland weighs about $\frac{2}{3}$ ounce (20 grams) and is about the size of a walnut. It consists of muscular and glandular tissue with a tough, fibrous covering.

Sperm are produced in the testicles and travel to the prostate through two tubes called the *vas deferens.* In the prostate, the vas deferens meet the ducts of two fluid-producing glands called *seminal vesicles.* Fluids produced by the prostate gland and seminal vesicles mix with sperm to form *semen.* Semen supports sperm and helps carry them out of the body through the urethra.

Enlargement of the prostate, also called *benign prostatic hyperplasia,* is common in men over 50 years old. An enlarged prostate can squeeze the urethra and cause frequent urination, difficulty urinating, or other symptoms. Treatment of an enlarged prostate depends on its size and the extent of symptoms. Doctors sometimes treat the condition with drugs. Other treatments destroy excess tissue with heat. In some cases, surgical removal of all or part of the gland is required. Enlargement of the prostate may also be caused by cancer (see **Prostate cancer**). Earl F. Wendel

See also **Reproduction, Human.**

Prosthetics, *prahs THEHT ihks,* is a branch of medicine that deals with supplying artificial body parts. An artificial part, called a *prosthesis,* replaces a body part lost due to disease or a birth defect. A prosthesis serves one or more of three basic purposes: (1) it duplicates, as well as possible, the functions of the missing part; (2) it provides structural support for remaining tissues; and (3) it improves the person's appearance.

A set of false teeth is an example of a prosthesis that serves all three purposes. A limb prosthesis provides a functional—and in some cases, cosmetic—substitute for a missing arm or leg. Some types of prostheses are implanted within the body. For example, diseased or damaged joints, particularly of the hip and the knee, may be replaced by functional prostheses made of metal and plastic. Synthetic arteries and veins may replace blocked or ruptured blood vessels. People with heart problems may receive artificial heart valves to replace faulty ones. An artificial breast is a type of cosmetic prosthesis used by some women who have had a breast removed because of cancer.



© Catherine Karnow, Corbis

Prosthetics deals with supplying artificial parts for the body. This Cambodian worker, who lost his own legs because of a land mine explosion, is preparing leg prostheses.

Some prosthetic devices perform the function of a defective body part but do not replace the part itself. For example, an implanted electronic mechanism called a *pacemaker* regulates the beating of the heart. Other devices replace an internal organ but are attached from outside the body. One such device is a *dialysis machine,* which does the work of the kidneys. Dudley S. Childress

See also **Artificial limb; Dentistry** (Prosthodontics).

Prostitution is the performance of sexual acts for payment. It exists throughout the world, largely in urban areas. Most prostitutes are women. But prostitutes also include men and children.

Some prostitutes work for themselves. Others work for men known as *pimps* or for women called *madams.* In many countries, *call services* or houses of prostitution, often called *brothels,* connect prostitutes with clients, set fees, and protect prostitutes from dangerous or unwanted customers. Some prostitutes seek customers on streets and in other public places. Both prostitutes and their clients face a risk of contracting sexually transmitted diseases, including AIDS (see **AIDS**).

In many Western countries, much prostitution is related to drug abuse. In the United States, for example, many prostitutes sell sexual services to support a drug habit. Psychologists and social scientists believe many people in developed countries become prostitutes because they have been emotionally, physically, or sexually abused as children or as adults. In developing countries, poverty is the main reason for prostitution.

In the United States, prostitution is legal only in Nevada, where each county has the option of allowing houses of prostitution. In Canada, call services are legal. But houses of prostitution are illegal, and prostitutes may not seek customers in public. Prostitution is also legal in parts of South America and Asia. Many European cities have experimented with legal prostitution.

People in Western countries disagree about whether prostitution should be legalized. Many people oppose prostitution on moral or religious grounds. Some people think that the legalization of prostitution results in a rise in the spread of sexually transmitted diseases. But others argue that legalization controls the spread of

such diseases because it enables governments to require medical inspection of prostitutes.

Prostitution has existed throughout history. It was widespread in ancient Egypt, Greece, Rome, and China. In European and Asian history, some prostitutes have held high social rank. Michele G. Shedlin

Protactinium, *proh tak TIHN ee uhm,* is a radioactive metal belonging to the actinide series of elements. Two teams of scientists independently isolated the element in 1917. These were Otto Hahn and Lise Meitner of Germany, and Frederick Soddy and John Cranston of Britain. Protactinium occurs naturally in all uranium ores. It is also produced artificially in nuclear reactors and in particle accelerators.

Protactinium has the symbol Pa. Its atomic number is 91, and its atomic weight is 231.03588. Its most stable isotope has a half-life of 33,000 years. Several chemical compounds containing protactinium are known. Protactinium metal melts at 1572 °C. Richard L. Hahn

Protea, *PROH tee uh,* is the name for a group of about 130 species of evergreen shrubs and small trees native to Africa. They grow to a height of 3 to 10 feet (0.9 to 3 meters). Proteas bear large flowers that may vary widely



WORLD BOOK illustration by John F. Eggert

Flower heads of the giant protea grow up to 8 inches (20 centimeters) wide. The flowers can be white, pink, or red.

in size, shape, and color, depending on the species. The flower heads are surrounded by many overlapping *bracts* (leaflike structures) that may be white, pink, or red. Proteas are named after Proteus, a Greek sea god who could assume many forms.

Only a few species of proteas are cultivated. Probably the most common is the *giant protea,* also called *king protea.* This plant has flower heads that measure as much as 8 inches (20 centimeters) wide. Cultivated proteas grow best in climates with dry summers and mild, wet winters. In parts of California, they are grown commercially for their flowers. They are useful as ornamental plants.

Proteas require well-drained, slightly acid soil. They are started by planting seeds in the fall. Proteas tend to develop fungal diseases during their first year of growth unless treated with a fungicide. Kenneth A. Nicely

Scientific classification. Proteas make up the genus *Protea* in the protea family, Proteaceae. The scientific name for the giant protea is *Protea cynaroides.*

Protection of wildlife. See Wildlife conservation.

Protective coloration is coloring that protects a plant or animal from its enemies. There are several forms of protective coloration that deceive enemies or warn them away. In *cryptic coloration,* the color and color pattern of a plant or animal blend in with the surroundings so that the individual is not easily discovered. For example, the coloration of many insects, reptiles, birds, and mammals that live in the desert closely matches the color of the sand. The stone plants of South Africa look like stones. Snowshoe hares and weasels have coats of brown hair during warm months and white coats during the winter.

In *disruptive coloration,* one part of an animal's body stands out more than the other parts so that the real shape of the body is not conspicuous. For example, the killdeer, a bird that lives in fields in North America, has a bold pattern of brown-and-white crossed with black stripes. An enemy sees several brownish lumps and may not recognize the outline of the bird.

Mimicry is a form of protective coloration in which a plant or animal strongly resembles another plant or animal. *Batesian mimicry* occurs when an animal that is otherwise defenseless against a particular enemy looks like an animal that is distasteful or dangerous to that enemy. For example, the viceroy butterfly has a color pattern similar to that of the monarch butterfly, which makes birds sick when eaten.

Some forms of protective coloration



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Cryptic coloration allows ptarmigans to blend into their snowy surroundings.



© Carson Baldwin, Jr., Animals Animals

Warning coloration protects a skunk by reminding the animal's enemies of its ability to spray a foul-smelling liquid.

Another form of protective coloration is called *warning coloration.* A number of brightly colored insects, such as ladybugs and bumblebees, taste bad or sting. Their warning coloration reminds a predator of past experiences with those insects and frightens it away.

Protective coloration has been developed over many thousands of years. Plants and animals protected by color survived and reproduced their kind. Those that were not protected died out. This process is called *natural selection.* Edward H. Burtt, Jr.

Related articles in *World Book* include:

Animal (Protective coloration)
Bird (Protection against enemies; pictures: Protective coloration)
Butterfly (How butterflies protect themselves; picture)
Fish (Skin and color)
Flounder
Mimicry
Walkingstick

Protective tariff. See Tariff.

Protein is one of the three main classes of food that provide energy to the body. The others are carbohydrates and fats. Proteins exist in every cell and are essential to plant and animal life. Plants build proteins from materials in the air and the soil. Human beings and animals obtain proteins from foods. Foods high in protein include cheese, eggs, fish, meat, and milk.

The structure of proteins. All proteins contain carbon, hydrogen, nitrogen, and oxygen. Some proteins also contain iron, phosphorus, and sulfur. Proteins are large, complex molecules made up of smaller units called *amino acids.* The amino acids are linked together into long chains called *polypeptides.* A few polypeptides are straight, but most are bent into complex three-dimensional shapes. A protein consists of one or more polypeptide chains.

Twenty common amino acids are assembled into the thousands of different proteins required by the human body. To assemble the proteins it needs, the body must have a sufficient supply of all these amino acids. Nine amino acids, called *essential amino acids,* either cannot be produced by the body, or are produced, but in insufficient amounts. Therefore, they must be supplied by various foods. The remaining amino acids, called *nonessential amino acids,* can be manufactured by the body in sufficient amounts.

Proteins in the diet. The best sources of proteins are cheese, eggs, fish, meat, and milk. The proteins in these foods are called *complete proteins* because they contain adequate amounts of all the essential amino acids. Cereal grains, *legumes* (plants of the pea family), nuts, and vegetables also supply proteins. These proteins are called *incomplete proteins* because they lack adequate amounts of one or more of the essential amino acids. However, a combination of two incomplete proteins can provide a complete amino acid mixture. To do so, each incomplete protein must have sufficient amounts of the essential amino acids of which the other incomplete protein contains small amounts. For example, a cereal grain, such as barley or corn, could be combined with a legume, such as peas or peanuts. The foods must be eaten together to provide the correct balance of amino acids.

In the United States, the Recommended Daily Dietary Allowance of protein for adults is 0.8 gram per kilogram (0.013 ounce per pound) of body weight. Infants and children need extra protein, as do pregnant women and nursing mothers.

Insufficient protein in the diet may cause lack of energy, stunted growth, and lowered resistance to disease. A protein shortage also may lead to *edema,* a condition in which fluids accumulate in body tissues, causing the tissues to swell. In developing countries, many infants and children have a disease called *kwashiorkor* as a result of eating little or no food containing complete proteins. Severe cases of kwashiorkor may cause liver damage and eventual death. See **Kwashiorkor**.

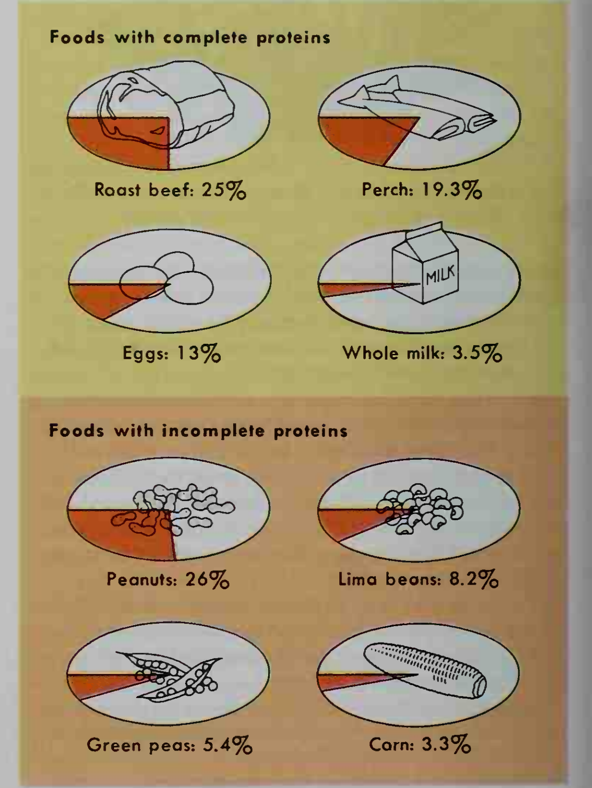
How the body uses proteins. Proteins make up a large part of each cell in the human body. Therefore, they are important in building, maintaining, and repairing tissues in the human body, especially bone cartilage and muscle.

In addition, every cell contains proteins called *enzymes,* which speed up chemical reactions. Without enzymes, the cells could not function. Certain proteins perform specific jobs. For example, the blood contains such proteins as *albumin* and *hemoglobin.* Albumin helps maintain the body's fluid balance by keeping water in the blood. Hemoglobin carries oxygen from the lungs to body tissues. *Antibodies* are proteins in the blood that help protect the body from disease. Chemical sub-

Protein content of selected foods

Foods vary in the amount and kind of protein they contain. Those with *complete proteins* provide enough of all the essential amino acids. Foods with *incomplete proteins* lack enough of one or more of these amino acids. But correct combinations of incomplete proteins can provide a balanced amino acid mixture.

WORLD BOOK diagram by David Cunningham



stances called *hormones,* many of which are proteins, control such processes as growth, development, and reproduction.

The body obtains most of its energy from carbohydrates and fats. However, the body uses proteins for energy when carbohydrates and fats cannot meet its energy needs. Proteins produce about 1,800 calories of energy per pound (4 calories per gram), the same amount provided by carbohydrates.

After proteins have been eaten, hydrochloric acid, which most people have in their stomach, causes the protein molecules to *coagulate* (thicken and clump together). Enzymes in the stomach and in the intestines break down the coagulated proteins into individual amino acids. The amino acids are absorbed into the blood and travel throughout the body. Every cell assembles the amino acids into the proteins it needs. This process is controlled by *DNA* (deoxyribonucleic acid), a substance in the nucleus of each cell. For a detailed description of how a cell produces proteins, see **Cell** (Producing proteins; The code of life).

Food containing proteins should be included in the daily diet because the body cannot store proteins for later use. The body converts excess proteins into carbohydrates and fats. If the body does not receive enough proteins from the food eaten, it uses proteins from the cells of liver and muscle tissues. However, continued use of such proteins by the body can permanently damage those tissues. Richard A. Ahrens

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Kwashiorkor
Life
Metabolism (Anabolism)
Milk (Nutrients in milk)
Nutrition

Proterozoic Eon. See **Earth** (Age of Earth).
Protest. See **Civil disobedience; Civil rights; Riot.**
Protestant Episcopal Church. See **Episcopal Church.**

Protestant ethic is a set of attitudes that stress the moral value of work, self-discipline, and personal responsibility. These principles developed from the Protestant belief that people do not live and work for themselves alone. People's work—or their *calling,* as it is sometimes termed—comes from God. People prove their worth to themselves, to their society, and to God by overcoming hardship through dedicated achievement, self-control, and moral living.

The Protestant ethic encourages people to work because of the belief that work is good. The ethic emphasizes self-denial to promote thrift, and it discourages spending large amounts of money for luxuries or personal pleasures. It also holds that unnecessary comforts distract people from their duty to God. The ethic does not view wealth as evil in itself. Wealth becomes evil only when it tempts people to idleness and sinfulness.

Personal responsibility ranks as one of the most important ideals of the Protestant ethic. For example, dedication, foresight, and thoughtfulness help a person succeed. The ability to resist temptation keeps a person from wasting energy, savings, and time. According to the ethic, a person is good if he or she is hard-working, honest, and thrifty. Such a person is more virtuous than one who is lazy, pleasure-seeking, and wasteful.

The concept of the Protestant ethic is closely associated with Max Weber, a German sociologist. In 1904 and 1905, Weber wrote a famous essay called "The Protestant Ethic and the Spirit of Capitalism." He maintained in this essay that the principles of the Protestant ethic contributed to the development of the economic system called *capitalism.* In capitalism, individuals and corporations control and direct the means of production. The hard work, investments, and savings of individuals help build a capitalist economy. Neil J. Smelser

See also **Reformation** (Political and social influences); **Weber, Max.**

Protestantism is the general name for hundreds of Christian denominations and sects that differ slightly or greatly from one another. About 380 million people—about 7 percent of the world's population—belong to these various groups. Among Christian bodies, only the Roman Catholic Church has more members.

Protestantism resulted chiefly from the Reformation, a religious and political movement that began in Europe in the early 1500's. The word *Protestant* comes from the Latin word *protestans,* which means *one who protests.* It was first used in 1529 at a *diet* (formal assembly) in Speyer, Germany. At the diet, several German leaders protested an attempt by Roman Catholics to limit the practice of Lutheranism, an early Protestant movement. The leaders became known as Protestants. The name soon came to include all of the Western Christians who had left the Roman Catholic Church.

Most Protestants live in Europe and North America, but the number of Protestants is increasing in such areas as Africa and Latin America. A Protestant denomination is the state religion of a number of nations, including Denmark, Norway, Sweden, and the United Kingdom. Protestantism has strongly influenced the cultural, political, and social history of these and other countries.

Protestant beliefs

Protestants share most Christian beliefs with members of the Roman Catholic and Eastern Orthodox churches. For example, Protestants believe there is only one God. Most members of Protestant denominations also believe that in God there are three Persons who together form the *Trinity.* These Persons are the Father; the Son, who is Jesus Christ; and the Holy Spirit. Protestants also believe in the central importance of Christ as the savior of humanity.

Historically, Protestants have disagreed most with other Christians over the ways human beings relate to God. As a result of this disagreement, Protestants have developed distinctive beliefs in certain areas. Two prominent Protestant beliefs involve (1) the nature of faith in God and the nature of the grace of God and (2) the authority of the Bible.

Faith and grace. Protestants oppose the Roman Catholic doctrine on salvation. Catholics believe that people achieve salvation by having faith in God's grace and by their own merit—that is, by doing good works. Protestants also stress the importance of faith, but reject the emphasis that Catholics place on good works.

According to Protestantism, God is first of all gracious—that is, He is loving and forgiving. He establishes and is responsible for His relationship with people. Protestants believe people are incapable of saving themselves because of their sins. Therefore, they are saved by the grace of God and not by their own merit. Protestants believe this grace of God comes to people through Christ. They regard Christ's death on the cross as a gift of God's grace. But this grace comes to those who have faith, not to those who do good works. Thus, people receive salvation by having faith in God's grace, which comes to them through Christ.

The authority of the Bible. The beliefs of Roman Catholics are based on both the Bible and the traditions of their church. These traditions come from the declarations of church councils and popes. They also come from short statements called *creeds* and from longer, formal statements called *dogmas.* Protestants, on the other hand, reject the idea that the pope should be the highest earthly Christian authority. Most Protestants believe that the Bible should be the only authority for their religion.

Through the centuries, several Protestant denominations have based their beliefs on other authorities in addition to the Bible. For example, certain churches believe that personal religious experience serves as a measure of their faith. Others believe they can test their faith through human reason or certain church traditions. But in general, the Bible remains the central religious authority for Protestants.

Worship and liturgy

Protestants worship only one God. But various denominations worship God in greatly different ways. Protestant *liturgies* (worship services) range from the simple, informal meetings of the Quakers to the elaborate ceremonies of certain Anglican churches. But despite many differences, most Protestant liturgies share such basic features as (1) faith in the word of God, (2) belief in sacraments, and (3) the importance of the laity.

Faith in the word of God. Most Protestant liturgies stress preaching and hearing the word of God. Protestants believe that God is present in their midst and inspires faith in them when they discuss, hear, and read the Bible. For this reason, most Protestant services focus attention on the preacher and the sermon.

Belief in sacraments. Various Protestant denominations disagree about the nature and number of solemn observances called *sacraments.* But most denominations include at least two sacraments—Baptism and the Lord's Supper—in their worship.

Baptism is a sacrament that, for some Protestants, represents the beginning of Christian life, so it can occur with infants. Others view baptism as a sign of a person's faith, in which case the person must be old enough to reason about its meaning. Most Christians connect baptism with God's gift of faith and grace.

The Lord's Supper, or Communion, is a ceremony that recalls Christ's words and actions at the Last Supper. Protestants believe that it either represents or expresses God's forgiveness of sinners.

The importance of the laity. Most Protestant churches stress the role of the *laity,* church members who are not clergy. Protestantism expects these people to participate in the liturgy through singing and prayer, and often encourages them to participate in the leading of worship and even to preach. Such participation establishes a sense of community in which God's word may be heard and His relationship to humanity understood.

History

Most Protestant denominations originated during the Reformation. But some, such as the Moravian Church, were beginning to take shape before the Reformation. The Reformation itself began in 1517 when Martin Luther, a German monk, protested certain practices of the Roman Catholic Church. By about 1550, Protestantism had spread throughout almost half of Europe. See **Reformation; Roman Catholic Church** (The Reformation and Counter Reformation).

Protestantism developed as a series of semi-independent religious movements. These movements resembled one another in their rejection of the central authority of the pope. But cultural, geographic, political, and religious differences caused them to develop independently in varying degrees. Many such differences resulted in the division of the larger movement into various denominations and sects.

Despite their differences, the various resulting Protestant movements can be divided historically into five general groups. These groups are (1) the conservative reform movements, (2) the radical reform movements, (3) the free church movements, (4) the Methodist movement, and (5) the unity movement.

The conservative reform movements (the 1500's). These movements include groups that broke away from the Roman Catholic Church but kept many basic beliefs of that church. Among such movements, in order of their establishment, are the Lutheran; the Reformed, or Presbyterian; and the Anglican, or Episcopalian.

The Lutheran movement, based on the teachings of Martin Luther, was the earliest major Protestant movement. It spread rapidly throughout northern Germany and the Scandinavian nations during the 1520's. Lutherans largely agreed on the importance of faith and the authority of the Bible. But they disagreed widely over the form of the liturgy and church government. These disagreements led Lutherans to split into several factions.

The Reformed, or Presbyterian, movement developed largely from the teachings of two reformers, Huldreich Zwingli and John Calvin. During the 1520's, Zwingli, a Swiss priest, urged reforms that were more radical than Luther's. In the 1530's, the French reformer John Calvin largely combined the ideas of Luther and Zwingli. Calvin's teachings strongly influenced people in England, France, the Netherlands, and Scotland. In England, many of his followers became known as *Puritans.* In France, they were called *Huguenots.* The Scottish reformer John Knox introduced Calvin's teachings in Scotland.

The Anglican, or Episcopalian, movement started in England. It resulted from the Act of Supremacy of 1534, in which King Henry VIII declared his independence from the pope. The Anglican Church became established in England only after much dispute and bloodshed. In 1559, Queen Elizabeth I established a moderate form of Protestantism that became known as Anglicanism.

The radical reform movements (the 1500's and 1600's). Some small religious sects differed widely from both the Roman Catholic Church and major Protestant churches. Most of these radical groups thought conservative Protestants had not reformed the Catholic Church enough. Many of the sects rejected conservative reforms and developed their own forms of worship.

The Anabaptists and other radical groups first appeared during the Reformation. Other radical sects developed in Europe and North America after the Reformation. They included the Quakers, the Separatists, and the Shakers.

The free church movements (the 1500's and 1600's). This group consisted of two movements, the Congregational and the Baptist. They developed chiefly from rigorous reform movements that came to be called Puritan. They took shape in early Reformation times.

During the late 1500's in England, various Puritans opposed certain policies of the Anglican Church. They believed they could not reform the church from within, and so they separated from it. This separation resulted in their being called *Separatists.* But they soon became known as *Congregationalists* because of their belief in the rights of local congregations.

In the early 1600's, an English clergyman named John Smyth led a group of Separatists to the Netherlands. He and his followers believed that only people who were old enough to express their faith should be baptized. Smyth's group became known as *Baptists.*

The free church movements spread into colonial America. The Pilgrims, a separatist group led by William Brewster, established the Plymouth Colony in 1620. In 1638, the religious leader Roger Williams founded a Baptist church in Providence in the Rhode Island Colony. By the 1920's, the Baptist Church ranked as the largest Protestant denomination in the United States.

The Methodist movement (the 1700's). Methodism developed largely from *pietism,* a religious attitude that began in Europe during the late 1600's. Pietism stressed the importance of personal devotion and morality as the most profound expressions of faith.

In the early 1700's, John Wesley, an English clergyman, set out to reform the Anglican Church, also known as the Church of England. Wesley preached doctrines that were *evangelical*—that is, they emphasized the need for personal religious experience. He was not satisfied by the Anglican response to his reform and, in 1744, he organized the Methodist movement. Methodism grew rapidly in England and, later, in the United States.

Pietism and various evangelical churches greatly influenced other Protestant denominations. Many missionary movements began, and Protestantism had spread throughout the world by 1900.

The more conservative and enthusiastic branches of Methodism gave birth to the Holiness movement, including the Nazarenes. In the early 1900's, the Holiness movement, in turn, inspired a movement called Pentecostalism. Pentecostalism has become one of the most rapidly growing forms of Protestantism. The Pentecostals are sometimes called *charismatics.*

The unity movement (the 1800's and 1900's). Since the mid-1800's, many Protestants and other Christians have shown an increasing desire to overcome their differences. They have sought to unite various Protestant denominations and to encourage cooperation through federations and councils. In addition, many of these people have worked to increase good will among Protestants and members of the Eastern Orthodox and Roman Catholic churches.

In 1846, a group in London formed the Evangelical Alliance to give individual Christians an opportunity to unite in friendship and discussion. During the early 1900's, the trend toward Christian unity became known as the *ecumenical movement.* Representatives of different Protestant denominations met with one another, as did representatives of Protestant churches and the Eastern Orthodox Churches. In 1948, church leaders founded the World Council of Churches. This organization works for cooperation and unity among all the churches of the world.

In 1965, Pope Paul VI expressed the need for unity among all Christians. He made the statement at the end of an ecumenical council called Vatican Council II. Many Protestants and other Christians welcomed the pope's expression of unity and the unifying spirit of the council itself. Martin E. Marty

Related articles in *World Book* include:

The Reformation

Anabaptists
Augsburg Confession
Calvin, John
Covenanters
Cranmer, Thomas
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Hus, John
Knox, John
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Laud, William
Lollards
Luther, Martin
Melanchthon, Philipp
Reformation
Ridley, Nicholas
Thirty-Nine Articles
Tyndale, William
Wycliffe, John
Zwingli, Huldreich

Later European Protestantism

Arminius, Jacobus
Barth, Karl
Bonhoeffer, Dietrich
Booth, Evangeline C.
Booth, William
Fox, George
Oxford Movement
Tillich, Paul
Watts, Isaac
Wesley, Charles
Wesley, John
Whitefield, George
Wilberforce, Samuel

American Protestantism

Allen, Richard
Asbury, Francis
Beecher, Henry Ward
Beecher, Lyman
Brewster, William
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Dyer, Mary
Eddy, Mary Baker
Edwards, Jonathan
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Fundamentalism
Graham, Billy
Great Awakening
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Mather, Increase
Mather, Richard
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Muhlenberg, John P.
Niebuhr, H. Richard
Niebuhr, Reinhold
Peale, Norman Vincent
Penn, William
Pike, James A.
Puritans
Revivalism
Sunday, Billy
Tennent, Gilbert
Tennent, William
Wigglesworth, Michael
Williams, Roger
Wise, John

Protestant churches and groups

See **Anglicans; Baptists; Lutherans; Methodists; Presbyterians;** and the articles on many of the churches listed in these articles. See also:

Adventists
Amanites
Amish
Assemblies of God
Brethren
Christian Reformed Church

Christian Scientists
Church of God in Christ, The
Church of the Nazarene
Churches of God
Congregationalists
Disciples of Christ
Doukhobors
Hutterites
Jehovah's Witnesses
Mennonites
Moravian Church
Pentecostal churches
Quakers
Reformed Church in America
Schwenkfelders
Seventh-day Adventists
Shakers
Swedenborgians
Unitarian Universalist Association
Unitarians
United Church of Canada
United Church of Christ

Protestant organizations

Bible Society, American
Christian Endeavor International
Gideons International
Moody Bible Institute
National Council of Churches
Salvation Army
Volunteers of America
World Council of Churches
Young Men's Christian Association
Young Women's Christian Association
Youth for Christ International

Other related articles

Evangelicalism
Family (Development of the Western family)
Protestant ethic
Religious life
Roman Catholic Church (The Reformation)

Additional resources

Coalter, Milton J., and others. *Vital Signs: The Promise of Mainstream Protestantism.* Eerdmans, 1996.
Dillenberger, John, and Welch, Claude. *Protestant Christianity.* 2nd ed. Macmillan, 1988.
Marty, Martin E. *Protestantism in the United States.* 2nd ed. Macmillan, 1986.
Ozment, Steven E. *Protestants: The Birth of a Revolution.* Doubleday, 1992.

Protist, *PROH tihst,* is the name of a group of organisms, most of which are microscopic. The group consists chiefly of such one-celled organisms as diatoms, protozoans, and certain algae. Protists make up the Protista, which is one of the five biological kingdoms of living organisms. The other kingdoms are Prokaryotae (prokaryotes), Fungi (fungi), Plantae (plants), and Animalia (animals).

The German zoologist Ernst H. Haeckel first proposed the idea of Protista in 1866. He included the organisms fungi and sponges in the group. Today, many biologists limit the kingdom to one-celled organisms that have a well-defined nucleus and typical *organelles.* Organelles are organlike structures that perform specialized functions. Many biologists classify one-celled organisms that lack a well-defined nucleus or typical organelles in the Prokaryotae kingdom. Most protists reproduce by *mitosis,* a process by which one cell divides into two separate cells. Some reproduce sexually. Irwin Richard Isquith

See also **Algae; Diatom; Euglena; Kingdom; Protozoan; Prokaryote.**

Protocol, *PROH tuh kahl,* is a document containing a record of talks carried on by diplomatic representatives. The document shows that the diplomats have agreed on important issues. A protocol is an official government paper, but it does not have the force of a treaty until ratified by the governments concerned (see **Treaty**). The term *protocol* also means the official etiquette of state ceremonies. Robert J. Pranger

Proton, *PROH tahn,* is a positively charged subatomic particle. A single proton constitutes the nucleus of an ordinary hydrogen atom. Protons, together with other subatomic particles called *neutrons,* make up the nuclei of all other atoms (see **Neutron**). All atoms of the same chemical element have the same number of protons. The number of protons in the atoms is called the *atomic number* of the element.

Ordinarily, an atom has an equal number of protons and *electrons,* negatively charged particles that surround the nucleus. Each proton carries one unit of positive charge, and each electron carries one unit of negative charge. As a result, the atom is electrically neutral.

Protons are made up of fundamental particles called *quarks* (see **Quark**). A proton has a diameter of approximately one millionth of a nanometer. One nanometer equals one millionth of a millimeter ($\frac{1}{25,400,000}$ inch). The mass of a proton in grams may be written with a decimal point followed by 23 zeros and a 2.

The proton was first identified by the German physicist Wilhelm Wien in 1902, and its identity was proved by the British physicist Sir Joseph J. Thomson in 1906. Scientists initially believed that protons would not naturally *decay* (break down) into other particles. However, mathematical *grand unified theories,* introduced in the mid-1970's, offered new insights about the fundamental forces that affect atoms and their nuclei. These theories predict protons can decay. Experiments to detect this decay are underway. Edward S. Fry

See also **Atom; Baryon; Electron; Gluon; Subatomic particle.**

Protoplasm, *PROH tuh PLAZ uhm,* is a term that means the living matter of cells. The term is little used by modern biologists because it is not specific. Johannes Purkinje, a Czech physiologist, first used it in 1839. At that time, scientists knew that all living things are made up of cells that seemed to contain a jellylike material. Purkinje named this material *protoplasm*—from Greek words meaning *first formed* or *molded*—to indicate it was the most basic substance of life.

Since that time, more powerful microscopes and advanced biochemical techniques have revealed more about the structure of the cell. Scientists have discovered that the jellylike material of cells is actually a complex mixture of proteins and other substances. The composition of this mixture varies among different types of cells and even from one part of a cell to another. Thus, biologists today use the terms *cytoplasm, nucleoplasm,* and *plasma membrane* to describe specific parts of the living cell matter (see **Cell** [Inside a living cell]). However, the word *protoplasm* is still sometimes used to describe the substance of a type of slime mold lacking cell boundaries at one stage of its life cycle.

Mary Lee S. Ledbetter

Protozoan, *PROH tuh ZOH ahn,* is a one-celled organism that may have plantlike or animallike characteristics. Scientists traditionally classified protozoans as animals and placed them in the phylum Protozoa. Today, however, many scientists group protozoans as neither animals nor plants. They place protozoans with other simple organisms in the kingdom Protista (see **Protist**). The study of protozoans is called *protozoology.*

Characteristics of protozoans

There are over 30,000 kinds of protozoans, most of them so small that they can be seen only through a

microscope. Protozoans live in moist places. They are found in salt water, fresh water, soil, plants, and animals.

Structure. The *ameba* is one of the simplest protozoans. The single cell that makes up its body carries on all the necessary life processes by itself. The cell eats, breathes, and responds to its surroundings.

Other protozoans are more complicated in structure. Some of them, called *ciliates,* have tiny hairlike projections that help them move about. The *paramecium* has a definite groove on one side that serves as a mouth.

Some protozoans have a bright red spot called the *eyespot.* This spot may be sensitive to light.

The bodies of some protozoans contain chlorophyll, the green substance also found in plants. Chlorophyll enables these protozoans to make their own food (see **Photosynthesis**).

Reproduction. Some protozoans reproduce by a process called *fission.* In this process, the original cell splits in two. Each half of the original cell becomes a separate individual. In other protozoans, the parent cell suddenly swells in one direction. The swollen part breaks off and forms a new protozoan. This process is called *budding.* Certain protozoans reproduce by dividing into many cells called *spores.* Other protozoans show the beginnings of sexual reproduction. In all these forms of reproduction, the cell's nucleus is divided among the new individuals. See **Reproduction**.

Importance. In spite of their small size, protozoans are very useful for both human beings and animals. Millions of protozoans swim in the sea, where they are eaten by sea animals. Some protozoans, such as the foraminifers, are covered with stony shells. When they die, they settle to the bottom of the ocean and contribute to the formation of limestone. The fossil shells of such protozoans are partly responsible for the chalk cliffs that are found in southern England.

Many protozoans are serious enemies of human beings and animals. Malaria and African sleeping sickness are among the diseases they cause.

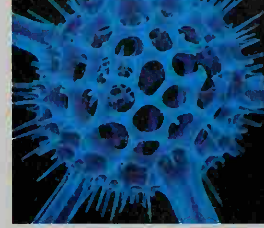
Types of protozoans

Protozoans can be placed into four groups on the basis of how they move: (1) flagellates, which have one or more whiplike *flagella;* (2) sarcodines, which include the amebalike protozoans; (3) apicomplexans, which move by gliding; and (4) ciliates, which have many hairlike *cilia.*



Manfred Kage from Peter Arnold

A flagellate



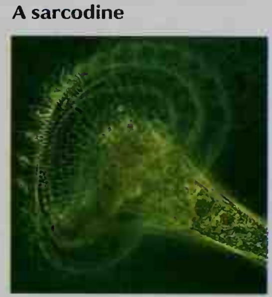
Manfred Kage from Peter Arnold

A sarcodine



CNRI from Science Photo Library

An apicomplexan



Manfred Kage from Peter Arnold

A ciliate

Types of protozoans

Protozoans can be divided into four groups on the basis of how they move about. These groups are (1) flagellates, (2) sarcodines, (3) apicomplexans, and (4) ciliates.

Flagellates have one or more long hairlike projections from their bodies called *flagella.* The flagella whip about rapidly to move the flagellate through the water. Flagellates are usually oval in shape, and many have chlorophyll in their bodies. The green *euglena* is shaped much like a submarine. It is common in fresh water. The *volvox* is a green ball of flagellated cells that live together. This ball moves about when the flagella of the individual members that make it up are whipped in the water. The *trypanosomes,* which cause African sleeping sickness, are also flagellates.

Sarcodines move by extending fingerlike *pseudopods* (false feet). A sarcodine forms these structures by pushing out its membrane. Sarcodines also use pseudopods to capture food. Sarcodines include the amebas and other amebalike protozoans. Many of the amebas live in the bodies of human beings and animals. Some cause disease, and others do not. For example, the harmless colon ameba is found in the large intestine of many healthy people.

Radiolaria are among this group of amebalike protozoans. Radiolarians have a tiny skeleton that is made of silica. After a radiolarian dies, this skeleton sinks to the ocean floor. Millions of shells have accumulated in parts of the ocean, forming thick layers of ooze. The *foraminifers* have shells made of chalklike material. Some of the ancient foraminifers were almost as large as a quarter. Geologists seeking oil study foraminifer fossil shells in rocks found below the surface. They indicate how the earth layers are arranged.

Apicomplexans make up a special group of protozoans that move by gliding. Protozoans of this type live as parasites. The malarial parasite is a well-known apicomplexan.

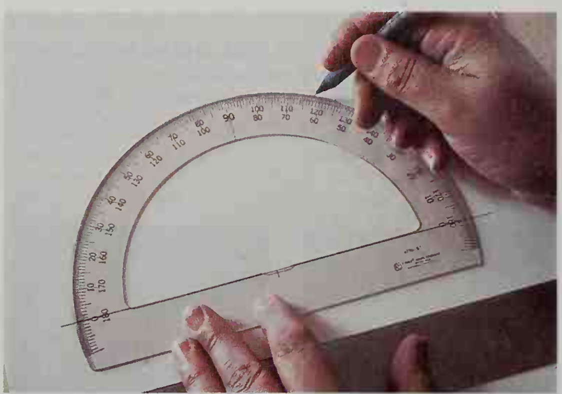
Ciliates are the most complex protozoans. All of them have, at one time or another, fine hairlike projections, which are called *cilia.* The cilia help the ciliates move about to capture food. The *stentors,* which are shaped something like a horn or trumpet, rank among the largest of all of the protozoans. Another kind of ciliate, the *vorticella,* looks something like a funnel with a long tube. The vorticella creates a little whirlpool around the top of the funnel to draw food into its body.

Lawrence C. Wit

Related articles in *World Book* include:

Ameba
Cell
Cilia
Euglena
Giardiasis
Paramecium
Trypanosome

Protozoology. See Protozoan.



WORLD BOOK photo by Odyssey Productions

A student uses a protractor to draw an angle.

Protractor is a device for measuring the size of angles or drawing angles of specified sizes. Protractors are made of plastic, paper, or metal. Most protractors are shaped like the letter D, with the arc in the shape of a semicircle. Lines and numbers on the arc indicate angles from 0 to 180 degrees (or, in some cases, from 0 to 3,200 mils).

To measure an angle, a straight edge of the protractor—or a line printed on it—is placed along one line of the angle. The reading is made where the other line crosses the arc. Full-circle protractors can read from 0 to 360 degrees. Todd I. Blue

Protura. See Insect (table).

Proudhon, *PROO DAWN,* **Pierre Joseph,** *pyair zhoh ZEHF* (1809-1865), was a French socialist, writer, and critic. In 1837, he published his *Essay on General Grammar.* This work won him a three-year pension from the Academy of Besançon. However, in 1840, Proudhon's *What Is Property?* lost him the academy's approval. The work revealed his socialistic ideas, and stated that "property is theft." Proudhon objected to the use of property to exploit the labor of others.

Proudhon wrote many other influential works, including *System of Economical Contradictions: or, The Philosophy of Misery* (1846). His radical ideas and political activities often led to trouble with the French government. As a result, he spent a number of years in prison and in exile. While in prison, he wrote several books.

Ideas. In 1848, Proudhon declared that his main inspirations were the Bible, the German philosopher G. W. F. Hegel, and the British economist Adam Smith. Proudhon was enthusiastic about the ideas of liberty, justice, and equality. His idea of liberty implied the rejection of all authority, except for that in the family. Unlike many other socialist writers, he had little use for the powers of government. He was an *anarchist*—that is, a believer in a social order without government (see **Anarchism**). Proudhon referred to his beliefs as *mutualist socialism.*

Proudhon argued that society should operate by means of contracts. These contracts should be voluntary agreements among free and equal peoples. He believed that contracts would establish a system of mutual rights and duties, which would result in justice.

In some of his works, Proudhon favored cooperation between working people and small proprietors. Such cooperation, he believed, would be more likely to bring about liberty, justice, and equality than would any action by the government.

Proudhon's work is not always consistent and is sometimes difficult to interpret. For instance, he urged equality, yet believed in the existence of inferior races and opposed increased political and social rights for women. His views often conflicted with those of other socialists, including the German social philosopher Karl Marx.

Early life. Proudhon was born in Mouillére, near Besançon, on Jan. 15, 1809. He studied at the College of Besançon. From 1843 to 1847, he worked in a printing plant in Lyon. He moved to Paris in 1848. Stephen Schneck

Proust, *proost,* **Joseph Louis,** *zhoh ZEHF lwee* (1754-1826), was a French chemist. He became known for helping prove the idea that every pure chemical compound consists of elements in a definite proportion. Today, scientists accept this idea as the *law of constant proportions.* In Proust's day, chemists disagreed on whether the proportion of elements in a compound was definite. Claude L. Berthollet, an influential French chemist, debated Proust for years on the subject in the early 1800's. Chemists accepted Proust's evidence as correct by about 1808.

Proust was born on Sept. 26, 1754, in Angers, France. When in his 30's, he moved to Spain. There, he taught chemistry in several universities and experimented in many areas of chemistry. He developed ways of obtaining sugar from grapes and did other research on foods. M. J. Nye

Proust, *proost,* **Marcel,** *mar SEHL* (1871-1922), was a French author. His seven-part novel *Á la recherche du temps perdu,* known in English as *Remembrance of Things Past,* is a masterpiece of literature. The novel's title has also been translated as *In Search of Lost Time.* It consists of *Swann's Way, Within a Budding Grove, The Guermantes Way, Cities of the Plain, The Captive, The Sweet Cheat Gone,* and *The Past Recaptured.*

Remembrance of Things Past is filled with vivid characters and provides a panorama of French high society in the process of change. It is a study of love, jealousy, marriage, and the evils of the age and describes the growth of the narrator, Marcel, into a mature artist. Marcel, except in one episode, is both participant and observer. He tells his story with frankness, intelligence, sensitivity, irony, and humor. The work has brilliant dialogue and offers original and profound observations about music, art, writing, theater, and criticism. Proust compared the novel's structure to that of a cathedral, whose diverse parts form a whole, or that of a musical composition in which themes are introduced, abandoned, and resumed.

To Marcel, reality remains elusive. It is constantly changing, because the passing of time alters not only his own perspective, but also the nature of what is perceived. He finally recognizes that reality is not external but something stored in the depths of one's unconscious memory. There it is preserved from the changes of time, but is accessible only in rare and happy moments. These moments are made possible by a variety of sensual experiences. The most famous example is that of the "madeleine," a small cake that brings back his childhood when he dips the cake into a cup of tea and tastes it. This enables him to live two moments in time together, and this defeats time itself. Artists can reveal

reality to humanity because their sensitivity lets them dig deeply into their own unconscious memory.

Proust began writing *Remembrance of Things Past* in 1908, but he could not find a publisher. He finally published *Swann's Way* in 1913 at his own expense. Both the author's poor health and World War I delayed the publication of later volumes until 1918. Proust continually revised the novel, and the last three parts were not published until after his death.

Proust was born in Paris. During the 1890's, he wrote stories and magazine articles that were noted for their elegant but artificial style. His unfinished novel, *Jean Santeuil* (1895-1899, published 1952), has characters and incidents that foreshadow his major novel. *Contre Sainte-Beuve* (1908-1910, published 1954) is a collection of critical essays that reveals Proust as a highly sensitive critic with theories on the arts that were far in advance of his time. Elaine D. Cancalon

See also **French literature** (The four masters).

Provençal. See **French language** (Old French); **Mistral, Frédéric; Troubadour.**

Proverb, *PRAHV urb,* is a brief saying that presents a truth or some bit of useful wisdom. It is usually based on common sense or practical experience. The effect of a proverb is to make the wisdom it tells seem to be self-evident. The same proverb often occurs among several different peoples. True proverbs are sayings that have been passed from generation to generation primarily by word of mouth. They may also have been put into written form. The Book of Proverbs in the Hebrew Bible, or Old Testament, is the most notable collection of such sayings. They include:

Hope deferred maketh the heart sick.
A good name is rather to be chosen than great riches.
A soft answer turneth away wrath.
Pride goeth before destruction, and
a haughty spirit before a fall.

Proverbs often find their way into literature. Many of the lower-class characters in *The Canterbury Tales* (late 1300's) by Geoffrey Chaucer refer to proverbs. Miguel de Cervantes' novel *Don Quixote* (1605, 1615) contains many proverbs. Cervantes collected the proverbs from the Spanish peasants, who supposedly could carry on a sensible conversation for a whole evening in nothing but proverbs (see **Don Quixote**).

Benjamin Franklin used many proverbial expressions in his *Poor Richard's Almanac,* issued every year from 1733 to 1758. Franklin wrote many of them himself, and took the rest from other sources. Many are still quoted (see **Poor Richard's Almanac**). Marcus Klein

See also **Epigram.**

Proverbs, Book of, is a book of the Hebrew Bible, or Old Testament. It is also known as the *Proverbs of Solomon* because, according to tradition, King Solomon wrote it. However, scholars believe that the book's assortment of moral and religious sayings, poems, and warnings come from various periods in the history of ancient Israel. They were probably not collected in their present form until after the period of the Babylonian Exile, which ended in 538 B.C.

The Book of Proverbs is a product of the educational system of ancient Israel. Children were educated primarily at home. The instructional value of many sections of Proverbs reflects the teachings of parents trying to raise their children to become successful and responsible adults. Other sections of the Book of Proverbs may come from a palace school for the training of government officials. The Book of Proverbs has earned universal appeal because it contains material valuable to all people who hope to live a life of wisdom, honesty, responsibility, self-control, and respect for God. Many of the book's sayings have become part of everyday speech. Carol L. Meyers

See also **Bible** (Books of the Hebrew Bible); **Proverb.**

Providence, *PRAHV ih duhns* (pop. 173,618) is the capital and largest city of Rhode Island. About a sixth of the state's people live in Providence, a major New England manufacturing center. Providence lies at the head of Narragansett Bay, in the east central part of the state. For location, see **Rhode Island** (political map).

Roger Williams, a religious leader in the American Colonies, founded Providence in 1636. The settlement was the first Rhode Island community founded by the colonists. Williams named it Providence because he believed God had guided him there. See **Williams, Roger.**

Description. Providence, the county seat of Providence County, covers about 20 square miles (52 square kilometers). Providence, Fall River, Massachusetts, and Warwick form a metropolitan area of about 1,141 square miles (2,955 square kilometers) with 1,188,613 people.

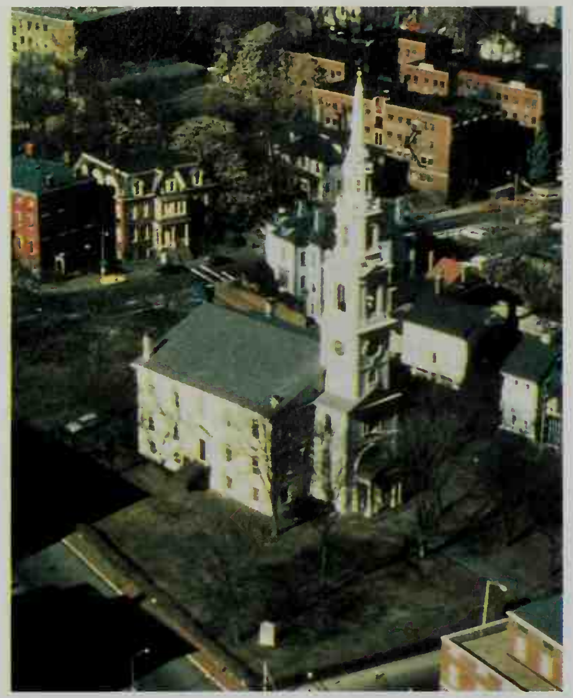
Providence is the home of Brown University, which was chartered in 1764 and ranks as one of the nation's oldest colleges. Other colleges in Providence include Providence College, Rhode Island College, Johnson & Wales University, and a campus of the University of Rhode Island. The Rhode Island School of Design, nationally known for its work in textile and industrial design, owns the Museum of Art. Public art galleries include the Wheeler Gallery and Brown University's List Art Gallery. The Rhode Island Philharmonic Orchestra performs at the Providence Performing Arts Center. The Trinity Square Repertory Company presents plays at the Lederer Theater.

Providence has preserved many colonial buildings. The John Brown House, built in 1786, serves as headquarters of the Rhode Island Historical Society. The house of Stephen Hopkins, a signer of the Declaration of Independence, dates from about 1743. The First Baptist Meeting House, built in 1775, is the oldest Baptist church in the United States. The Old State House was the meeting place of Rhode Island's General Assembly from 1762 until the present State House opened on Jan. 1, 1901. The State House, made of white marble, has a dome that is 50 feet (15 meters) in diameter. Only St. Peter's Basilica in Rome has a larger unsupported marble dome. See **Rhode Island** (picture: The State House).

Roger Williams Park, the largest of the city's 35 parks, covers about 430 acres (175 hectares). The Roger Williams Park includes a museum of natural history, a zoo, and a planetarium.

Economy. The metropolitan area has over 2,000 manufacturing plants. The plants employ about 90,000 people and produce much of the world's jewelry, especially costume jewelry. The area's other products include electronic devices, marine equipment, nonelectrical machinery, primary metals, scientific instruments, silverware, textiles, and wire and cable.

Freight and passenger railroads serve Providence.



Rhode Island Department of Economic Development

The oldest Baptist church in the United States is in Providence. The building was completed in 1775 and serves as the meeting house of a congregation founded in 1639.

The Theodore Francis Green State Airport lies south of the city. Activity at Providence's port fell sharply in the late 1980's. Providence has one daily newspaper, *The Providence Journal-Bulletin.*

Government and history. Providence has a mayor-council form of government. The mayor serves a four-year term. The council consists of 15 members, each of whom serves for four years.

Roger Williams founded Providence in 1636. He had been forced to leave the Massachusetts Bay Colony because he disagreed with its rules on religion. Williams established Providence as the only settlement in the American Colonies that assured religious freedom.

In 1775, about 4,300 people lived in Providence. The first hand-operated cotton-spinning device in the United States was built there in 1787. In 1790, in nearby Pawtucket, Samuel Slater, a textile worker from England, built the first water-powered machines for spinning cotton in the United States. These events helped start the U.S. textile industry, and Providence became one of its centers.

The city's jewelry industry began in 1794, when Nehemiah Dodge, a Providence businessman, found a way to cover cheap metals with precious metals. The textile industry expanded through the years, aided by large markets in Boston and New York City. By 1880, the population of Providence had grown to 104,857. Providence received a city charter in 1832. It served as one of several capitals of Rhode Island from 1663 until 1900, when it became the state's only capital.

Providence industries prospered during World War I (1914-1918) and World War II (1939-1945). Their factories made military supplies and other war materials, and Providence shipyards built combat and cargo ships. In the 1920's, many Providence textile plants moved to the South to take advantage of lower labor and transportation costs. Many other textile plants left the city in the mid-1900's, and Providence's population fell from 248,674 in 1950 to 156,804 in 1980. But after 1980, the population began to increase again gradually.

During the 1970's, Providence began to rebuild its downtown area. The first project, called Weybosset Hill, was completed in 1981. It covered 27 blocks and included apartment and office buildings and the Civic Center. The Civic Center houses a sports arena, convention center, and exhibition hall. The downtown Capital Center Project is expected to be completed by the early 2000's. A major highway interchange, shops, office and apartment buildings, a boulevard around downtown, hotels, a convention center, and a shopping mall have been built. Stanford E. Demars

For the monthly weather in Providence, see **Rhode Island** (Climate).

Province, in Roman times, was a conquered district ruled by an official from Rome. Later, independent countries that united to form a state frequently called themselves provinces. An example is the United Provinces of Holland. Still later, independent countries were divided into provinces.

In North America, the term *province* usually refers to one of the political divisions of Canada. There are 10 of these provinces. Each has its own local government. Canadian provinces perform much the same functions as American states.

See also **Canada, Government of** (Provincial and territorial governments); **Charter.**

Provincetown. See **Mayflower; Cape Cod.**

Provisional government is a temporary government frequently set up during or after a revolution or other disorder. Provisional governments are usually established because of a breakdown or rejection of the previous constitutional system. They are intended to facilitate the establishment of another constitutional government. Alexander J. Groth

Provo, *PROH voh* (pop. 105,166), is one of the largest cities in Utah. Provo was named for Étienne Provost, an early fur trapper. The city lies at the foot of the Wasatch Range, at an altitude of 4,549 feet (1,387 meters), and overlooks Utah Lake to the west. Provo is about 40 miles (64 kilometers) south of Salt Lake City (see **Utah** [political map]). Provo and nearby Orem form the heart of a metropolitan area with a population of 368,536.

Provo is the seat of Utah County, an industrial and agricultural region. The Geneva Steel plant is near the city. Many computer software companies have their headquarters in the Provo-Orem area. Provo is the home of Brigham Young University. The city's week-long Fourth of July celebration is one of the nation's largest and oldest patriotic festivals. Ute Indians first occupied the area. In September 1776, a party of exploring missionaries led by Father Silvestre Escalante, a Spanish priest, mapped the area. Provo was founded in 1849 by Mormon pioneers. The city has a mayor-council form of government. Dale J. Stevens

Proxmire, *PRAHKS my uhr,* **William** (1915-), a Wisconsin Democrat, was a United States senator from

1957 to 1989. He won a special election to fill the seat left vacant when Senator Joseph R. McCarthy died. Proxmire served as chairman of the Senate's powerful Banking, Housing, and Urban Affairs Committee from 1975 to 1981 and from 1987 to 1989.

As a senator, Proxmire took a liberal stand on most issues. He sponsored the Consumer Credit Protection Act of 1968, often called the Truth in Lending Act. This act requires businesses to state charges for loans and installment purchases in terms of the true annual interest rate. In 1971, he led a Senate campaign to halt government funds for development of a supersonic transport airplane. He also criticized wasteful military spending.

Proxmire was born in Lake Forest, Ill. He graduated from Yale University in 1938 and received an M.B.A. degree from Harvard University in 1940. From 1941 to 1946, he served in the Army. Proxmire was an assemblyman in the Wisconsin legislature in 1951 and 1952, and he headed a Wisconsin newspaper chain from 1954 to 1957. William J. Eaton

Proxy is a substitute. Suppose you have been assigned to deliver an important report before a meeting of your club. On the day of the meeting you are too ill to attend. You therefore call upon another club member to act for you. This club member becomes your *proxy* and delivers your report to the club meeting.

The use of a proxy is limited almost entirely to business meetings. A stockholder in a corporation who is unable to attend a corporation meeting may request another stockholder to act as a substitute and vote on any issue. This must be a formal request. The person who casts the vote is known as a proxy. The paper that authorizes the substitute to vote is also called a proxy.

In political elections, voting by proxy is forbidden. But at political conventions, many delegates vote by proxy.

In law and the social sciences, an easily measured trait is sometimes said to be a proxy for a trait that is more difficult to measure. For example, in laws that prohibit the drinking of alcohol by minors, a person's age is a proxy for maturity. Jethro K. Lieberman

Prune is a sweet plum that has been dried. The drying gives prunes their wrinkled appearance. Plums that are especially well suited to drying have a high sugar content and are called *prune plums.* Prunes are high in iron and vitamins.

Prune plums were first grown in western Asia, near the Caucasus Mountains and the Caspian Sea. Today they are a leading crop in California, where about 160,000 short tons (145,000 metric tons) of prunes are produced yearly. The warm, dry climate of the fertile valleys provides ideal growing conditions. Prunes are also grown in the northwestern part of the United States, central Europe, and South America.

The French prune plum (Petite d'Agen) makes up 90 per cent of the prune production in California. It was brought to the United States from France in 1856 by Louis Pellier, a fruit grower. Other prune plums include the Imperial, the Sugar, and the Robe de Sergeant.

Prune plum trees usually produce a crop five to seven years after planting. The trees bloom in spring. The fruit develops in summer. In August or September, the fully developed fruit falls to the ground or is machine harvested. It is then taken to a dehydrator in lug boxes or portable bins, where it is placed for a few seconds in a hot lye solution. The dehydrator dries the plums with a forced draft of hot air. The drying lasts from 14 to 24 hours and reduces 3 pounds (1.4 kilograms) of fresh plums to about 1 pound (0.5 kilogram) of prunes.

The prunes are placed in bins, where they are *cured* for at least two weeks. Curing gives the prunes a uniform moisture content of between 18 and 20 per cent. The prunes are then graded according to size, and may be pitted. Before the prunes are packed to be sold, they are given a hot water or steam bath to pasteurize them and to bring their moisture content to between 26 and 32 per cent. James E. Pollard

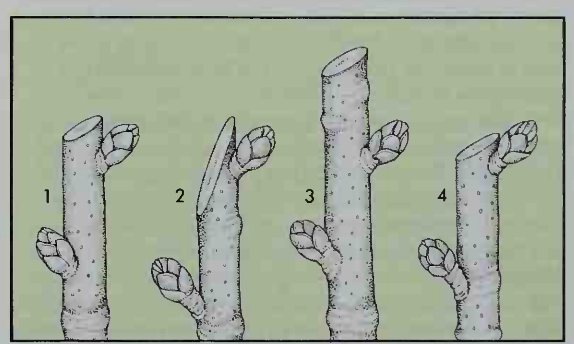
See also **Plum**.

Pruning is the cutting away of plant parts, such as branches, shoots, buds, or roots. Pruning serves various functions. It helps plants recover from the shock of being moved. It controls the shape and appearance of plants. Pruning also contributes to the size, quantity, and quality of fruit.

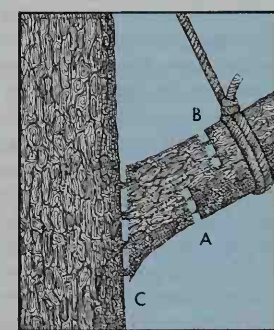
Transplanted trees and shrubs are pruned to prevent water loss through the leaves. As much as three-fourths of the leaf-producing area often must be removed to prevent excessive water loss. However, the top of a shade tree should not be pruned, because such pruning would destroy the shape of the tree. Spruce, pine, and similar evergreens usually are not cut. They develop naturally into their characteristic shapes.

Gardeners remove weak stems from shrubs at ground level. The diseased and broken branches are also removed. Shrubs that flower early in the spring, such as lilacs, should be pruned just after they flower. Shrubs that flower in the summer, like hybrid tea roses, are pruned in the spring. Gardeners shear hedges to encourage dense and compact growth and to keep the hedges in a desired shape.

Fruit growers prune their fruit trees annually. By cut-



WORLD BOOK illustrations by Patricia J. Wynne



Principles of pruning. Figure 1 in the illustrations above shows a correctly pruned branch. The angled cut is just above the bud. In figure 2, the angle of the cut is too sharp. The cut in figure 3 is too high above the bud, and in 4 it is too close to the bud. The correct method of removing a tree limb is shown at the right. The limb is cut halfway through at A and then at B before it is cut close to the trunk at C.





J. A. Barden, Photo/Nats

Pruning often involves removing certain top branches so that lower ones can receive more sunlight. These photographs show, *left to right,* an apple tree before and after pruning. The wooden boards placed in the pruned tree force the branches to grow in the desired direction.

ting out undesirable parts, they obtain low trees with open tops. Such pruning allows light to reach all parts of the tree. It also makes spraying the trees and picking the ripe fruit easier. Well-pruned trees produce high-quality fruit. Trees pruned so that the limbs are well spaced are less likely to break when the fruit loads down their branches.

Training of a fruit tree begins when the tree is transplanted in the field from the nursery. At that time, the grower prunes the tree to a height of 36 inches (91 centimeters). This pruning stimulates the development of branches. The next year, the grower selects the strongest and best branches to remain on the tree and cuts the others off. In their early years, fruit trees require little pruning. Old trees are pruned more heavily to allow light to reach the branches and to help fruit-bearing limbs grow in desired locations. George C. Martin

Prussia was a powerful Germanic nation in north-central Europe for hundreds of years. In the 1860's and early 1870's, Prussia unified the many independent German states, creating the German Empire in 1871. The Prussian king became emperor. Prussia was the largest and most powerful state in the newly unified Germany. After World War II (1939-1945), Prussia was broken up into small districts and ceased to exist as a German state. Much of the land once called Prussia now lies in Lithuania, Poland, Russia, and eastern Germany.

Prussia was more than the name of a country, however. It also represented a military way of life. Prussian armies were among the most rigidly drilled and disciplined in the world. Their generals were from the aristocratic landowning class and owned large estates.

The land and its resources. At the height of its power in the late 1800's, Prussia occupied most of the northern two-thirds of Germany. Prussia controlled territory that extended from Belgium and the Netherlands on the west to Russia on the east. The North Sea and the Baltic Sea bordered Prussia on the north. Austria-Hungary lay to the south. Prussia's main cities were Berlin, which was the capital, and Königsberg (now Kaliningrad), which was located in East Prussia.

Prussia had a low, sandy coast, bordered by many lagoons. The coast was separated from the central plain of Prussia by a belt of lakes and tree-covered hills. The central plain contained many lakes and waterways. Highlands south of the plain contained deposits of many minerals, including coal, iron, silver, copper, nickel, and lead. The most fertile land for farming lay in the valleys of the Oder, Elbe, and Rhine rivers.

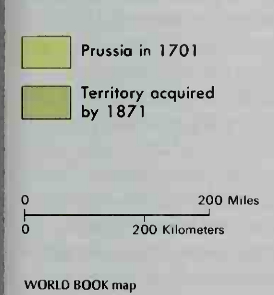
The Prussian people. The rulers of Prussia were headed by the royal family of Hohenzollern. They controlled lands originally populated by Slavs, and conquered and colonized by Germans in the Middle Ages. By the late 1500's, a small number of aristocratic landlords, called *Junkers,* had come to own most of the land in Prussia. The people who worked on the Junkers' estates were called *serfs.* Serfs rarely owned their own land. They were bound from birth to their lord's estate and were obligated to farm the lord's land. Male serfs were also forced to serve in the army.

Early history. The story of the rise of the Hohenzollern family is the story of Prussia. The Hohenzollerns were a family of German counts. In 1415, Holy Roman Emperor Sigismund made Frederick of Hohenzollern the ruler, or *margrave,* of the large district, or *mark,* of Brandenburg. In 1417, Frederick received the title elector of Brandenburg, which allowed him and his successors to take part in elections of the Holy Roman emperors. In the 1600's, the Hohenzollerns added East Prussia and Pomerania to their territory.

Prussia was greatly strengthened during the rule of the Great Elector, Frederick William, from 1640 to 1688. His son, Frederick I, was crowned the first king of Prussia in 1701. He built a strong army.

Frederick II, or **Frederick the Great,** became king of Prussia in 1740. He was an enlightened ruler who believed that the king's duty was to be "the first servant of the state." Frederick II helped shape a government based on discipline and authority, whose primary function was to support the Prussian military.





Prussia became the greatest military power in Europe during the 1800's. It began as the German district of Brandenburg and grew into the Kingdom of Prussia in 1701. Prussia reached its peak in 1871, when it became the largest state in the newly formed German Empire.

WORLD BOOK map

Using the strong army his father had organized, he seized Silesia from Austria in 1740. In the late 1700's, he expanded Prussia further by taking part of Poland.

Napoleonic period. Less skillful rulers followed Frederick II, and Napoleon easily defeated the Prussians in 1806. Reformers initiated changes hoping to restore Prussia's power. The Junkers lost their near monopoly of the land and of officer posts in the army. The serfs were freed, and a few peasants gained land. Army reformers established universal military training and invigorated the army with patriotic spirit. A Prussian army commanded by Gebhard von Blücher helped defeat Napoleon at Leipzig in 1813 and at Waterloo in 1815.

German empire. Prussia reached the peak of its power after King Wilhelm I was crowned in 1861 and chose Otto von Bismarck as prime minister. Bismarck strengthened the Prussian army and set out to unify Germany under Prussian control. In 1864, Prussia and Austria gained the Danish duchies of Schleswig and Holstein. A quarrel between Austria and Prussia in 1866 led to the Seven Weeks' War, which Prussia won. Prussia then formed the North German Confederation, unifying all of Germany north of the Main River. In 1870, Bismarck maneuvered France into war. Germany's success in the war enabled Bismarck to persuade Germany's southern states to join with the North German Confederation in forming the German Empire. The empire was established in 1871 with King Wilhelm I as its first *kaiser* (emperor).

Decline of Prussia. Prussian militarism was one cause of World War I (1914-1918), a war that Germany lost. In the peace settlement, Poland gained a strip of land called the *Polish Corridor.* This land separated East Prussia from the rest of Germany. World War II began after German dictator Adolf Hitler invaded Poland to reclaim the land lost in World War I. Prussian generals, some of them Junkers, commanded many of Hitler's armies. But some Prussian Junkers opposed Hitler and were executed after they plotted to assassinate him. The war brought heavy destruction to Prussia.

When the war ended, the Allies gave the northern half of East Prussia to the Soviet Union. The rest of Prussia east of the Oder and Neisse rivers, along with the city of Stettin (now Szczecin), became part of Poland. In 1947, the Allied Control Council legally abolished the state of Prussia. Robert M. Berdahl

Related articles in *World Book* include:

Berlin
Bismarck, Otto von
Blücher, Gebhard von
Brandenburg
Franco-Prussian War
Frederick II (of Prussia)
Frederick III (of Prussia)
Frederick William (of Brandenburg)
Frederick William I (of Prussia)
Germany
Hindenburg, Paul von
Hohenzollern
Junkers
Louise of Mecklenburg-Strelitz
Polish Corridor
Seven Years' War
Succession wars
Wilhelm
World War I
World War II

Prussian blue is a dark blue solid substance with a coppery luster. It was formerly used in the manufacture of laundry bluing, paint, and blue ink. Aniline products, however, are replacing Prussian blue for these purposes (see **Aniline**). The chemical is prepared commercially by mixing ferrous sulfate and sodium ferrocyanide, and then adding sodium chlorate. Prussian blue does not crystallize or dissolve in water. But alkalis will decompose it (see **Alkali**). Its chemical formula is $Fe_4[Fe(CN)_6]_3$. A color used in oil painting is also called Prussian blue. Howard L. Needles

Prussic acid, also known as *hydrocyanic acid,* HY *droh sy AN ihk,* is called *prussic acid* because it was first obtained from Prussian blue (see **Prussian blue**). The pure acid is a clear liquid. It has a low boiling point and evaporates quickly at room temperature. The acid has a faint odor of bitter almonds. It interferes with the body's ability to use oxygen and is one of the most poisonous substances known. Hydrocyanic acid gas has been used to execute condemned criminals. The gas is created when lumps of sodium or potassium cyanide are dropped into sulfuric acid. Hydrocyanic acid is also used to control the scale insect on orange trees. The

acid's chemical formula is HCN. The salts of this acid have many industrial uses. Marianna A. Busch

See also Cyanide.

Przewalski's horse, *puhr zheh VAHL skihz,* also called *Przhevalski's horse,* is the only true wild horse that exists today. Other "wild" horses, such as those found in the western United States, are actually descendants of runaway domestic horses. The Russian explorer Nikolai M. Przewalski found the skin and skull of one of these wild horses in central Asia in 1881. About 20 years later, animal collectors caught 32 colts.

Przewalski's horse is related to the domestic horse, but it resembles a donkey. It has a grayish-brown coat, a brown mane, and a black streak along its back. There are faint bars on its upper legs, and its lower legs are black. Przewalski's horse stands about 53 inches (135 centimeters) tall at the shoulder. It is an endangered species. More than 1,500 of these horses live in captivity. In 1995, scientists began a program to release captive-bred Przewalski's horses into the wild in an effort to reestablish them in their natural habitat. Steven D. Price

See also Horse (Wild horses; picture); Tarpan.

Scientific classification. Przewalski's horse belongs to the family Equidae. It is *Equus przewalskii.*

Psalms, *sahmz* or *sahlmz,* **Book of,** is a collection of 150 poems or songs in the Old Testament, or Hebrew Bible. The book is sometimes called the Psalter. The Psalms were probably part of the religious ceremonies of the ancient Israelites. Even today, the Psalms are used in both Jewish and Christian worship services.

Much of the Old Testament consists of the history of Israel or God's commands to His people. The Psalms are a special part of the Old Testament because they tell about people's personal responses to God. The Psalms reveal the individual's feelings when faced with both the joys and the sorrows of everyday life. The Psalms contain hymns praising and thanking God and prayers to God in times of trouble. Perhaps the best known Psalm is number 23, which begins, "The Lord is my shepherd; I shall not want."

The Book of Psalms is associated with the Israelite leader King David. According to tradition, David wrote 73 of the Psalms. However, many modern scholars doubt that he wrote all of them. Other musicians may have written the Psalms to honor him. King David was a famous musician, and the Psalms were probably an important part of the musical life of ancient Israel.

Many of the Psalms were probably written in King David's time, about 1000 B.C. Some of the Psalms may have been based on ancient Near Eastern songs and thus could be even older. Many Biblical prophets were influenced by the Psalms. Therefore, much of the book had probably been established by the age of prophecy in ancient Israel, which began in the 700's B.C. Some Psalms may reflect historical events that took place as late as the 500's B.C. Carol L. Meyers

Pseudonym, *SOO duh nihm,* is a fictitious name taken by authors and other people who wish to conceal their true identities or simply to be known by another name. One famous author's pseudonym is Mark Twain, the name adopted by the American humorist Samuel Langhorne Clemens. The "stage names" assumed by actors and actresses are also kinds of pseudonyms. See also Name (Other names). Marcus Klein

Psi particle, *sy,* also called a *J particle,* is a type of subatomic particle. A psi particle consists of a *quark* and an *antiquark.* A quark is an elementary particle that combines with other quarks to form such familiar particles as protons and neutrons. An antiquark has the same properties as a quark but carries an opposite electric charge. In a psi particle, the quark is a *charm quark,* and the antiquark is an *anticharm quark.* See Quark.

The structure of a psi particle is similar to that of a hydrogen atom. Both a hydrogen atom and a psi particle consist of two particles bound together. However, the components of a hydrogen atom—a proton and an electron—are bound together by electromagnetism. The quark and antiquark of a psi particle, on the other hand, are held together by the *strong nuclear force,* also called the strong interaction (see Force [The strong force]). Just like a hydrogen atom, a psi particle carries no electric charge.

The psi particle was discovered in 1974 by two groups of American physicists working independently at the Stanford Linear Accelerator Center and Brookhaven National Laboratory. The discovery of the psi particle and the study of its properties provided strong evidence for the existence of the quark. Stanley G. Wojcicki

Psittacosis, *SIHT uh KOH sihs,* is a contagious disease that is carried by some kinds of birds. The disease is also called *parrot fever* or *ornithosis.* Psittacosis occurs mostly in members of the parrot family, but is also found in pigeons and some poultry. Human beings can contract this disease by handling sick birds or infectious articles.

Psittacosis is caused by a type of bacteria called a rickettsia. Symptoms include nausea, diarrhea, chills, and high fever. Antibiotics will cure some cases, but serious infections can cause pneumonia or death. Because of this disease, the government forbids the importation of parrots into the United States without rigid inspection.

John W. Fitzpatrick

Psoriasis, *suh RY uh sihs,* is a skin disease marked by red patches of dry, scaly skin. Mild cases of psoriasis affect only small areas of the skin, while more severe attacks may cover the entire body. In skin afflicted with psoriasis, cells multiply at an abnormally high speed. These cells do not *exfoliate* (peel away) properly. Also, blood vessels beneath the skin enlarge and release chemicals that cause swelling.

Psoriasis is not contagious. However, infection, medicine, or an injury to the skin may cause an attack of psoriasis. Emotional factors, such as tension, may also influence outbreaks. Many people afflicted with psoriasis have a history of psoriasis outbreaks in their family. Doctors believe that psoriasis may be a *genetic disease,* a disease that is inherited from a parent. Many people with psoriasis also suffer from a form of arthritis, but the skin patches themselves do not cause arthritis.

Although psoriasis cannot be cured, *dermatologists* (skin doctors) can treat its symptoms. For mild cases, dermatologists often apply medicine directly to the skin. Cortisones, coal tar, and a drug called anthralin reduce swelling, slow cell growth, and relieve itching. Doctors can also apply chemicals, such as salicylic acid and urea, to force the excess skin to peel away. Vitamin D solutions can slow the rate at which skin cells multiply. In more severe cases, physicians shine ultraviolet light on

the skin to slow the growth of skin cells. As a last resort, doctors may prescribe oral medicine for psoriasis. With proper treatment, psoriasis can be cleared up for long periods. Alan K. Silverman

Psyche, *SY kee,* was a princess in ancient mythology. She was so beautiful that people turned to worshiping her instead of Venus, goddess of love. Venus became angry and sent her son Cupid (Love) to punish her. However, Cupid fell in love with Psyche and carried her off to his fairyland palace of gold and gems. Cupid visited Psyche only at night and told her that, if she ever saw him in the light, he must leave her forever. But Psyche, urged by her wicked sisters, one night lighted a lamp to see Cupid as he slept. He awoke and left her.

In her grief, Psyche searched for Cupid, finally arriving at the palace where Venus was living. The goddess made Psyche her slave and gave her four nearly impossible tasks. Psyche performed the first three, but in the fourth, a visit to the queen of the underworld, Psyche failed and became trapped in the underworld. Cupid, however, rescued her. With the help of Jupiter, king of the gods, Cupid won Venus's forgiveness and made Psyche a goddess and his wife. See **Cupid.**

The story of Cupid and Psyche has been interpreted symbolically. According to this interpretation, Psyche (which means *soul* in Greek) represents the human soul's encounter with love and passion (Cupid) and its struggle to achieve immortality. Jon D. Mikalson

Psychedelic drug. See **Hallucinogenic drug.**

Psychiatry, *sy KY uh tree,* is the branch of medicine concerned with the treatment and prevention of mental illness. A psychiatrist is a physician who, after earning an M.D., takes at least four years of training in the treatment of mentally ill patients.

Many techniques are used in treating mentally ill patients. A psychiatrist might discuss problems with one patient; prescribe drugs for another; and combine discussions, drugs, and other therapy for a third.

Some psychiatric therapy takes place in a psychiatrist's office or in a clinic. But severe cases require hospital care. Many hospitals and clinics employ psychiatric nurses, psychiatric social workers, and clinical psychologists. These specialists have had special training to help patients solve their problems.

Psychiatric disorders

Mental disorders are characterized by a variety of symptoms, such as abnormal moods or behavior, excessive anxiety, and hallucinations. These symptoms often upset the person who experiences them and may interfere with the person's ability to lead a normal life. The causes of most mental disorders are unknown. Some may arise from emotional conflicts or psychological stress. Others may result from learned behavior patterns or are caused by biological defects in the brain. Many mental disorders are believed to result from a combination of emotional, social, and biological factors.

Ways of defining and classifying mental disorders have changed over time. Older classification systems made a distinction between *psychoses* and *neuroses.* Psychoses are severe mental disorders in which a person loses touch with reality and experiences such symptoms as delusions and hallucinations (see **Psychosis**). Neuroses are milder disorders marked by excessive anxiety (see **Neurosis**). Other kinds of mental disorders include *dementias* and *personality disorders.* Dementias are abnormalities in thinking or behavior caused by brain injury or brain deterioration. Personality disorders involve a tendency to act in socially unacceptable or self-defeating ways. Most psychiatrists in the United States use a classification system published by the American Psychiatric Association in 1994. This system includes more than 100 types of mental disorders defined by their symptoms.

Treatment

Psychiatrists use a number of treatments for mental disorders. The two main types of treatments are (1) somatic therapy and (2) psychotherapy.

Somatic therapy usually involves the use of medications. One commonly used group of medications are *neuroleptic* drugs, sometimes called *antipsychotics.* These drugs are used mainly to treat psychosis. *Antidepressants* are a group of drugs used to control abnormalities of mood. *Anxiolytics* reduce anxiety and are used chiefly to treat conditions characterized by excessive anxiety, including phobias and panic disorder. *Lithium carbonate* is a drug used to treat *bipolar disorder,* also called *manic-depressive disorder.* A person with this disorder experiences alternating periods of sadness and joy.

A type of somatic therapy called *electroconvulsive therapy* is sometimes used to treat severe depression. In this type of therapy, a mild electric current is passed through the patient's brain after the patient has been given a drug that causes sleep. See **Mental illness** (Electroconvulsive therapy [ECT]).

Psychotherapy is any form of treatment by psychological means. There are many types of psychotherapy. Most psychotherapy is based on discussions between the patient and the psychiatrist. The doctor works to build the patient's confidence and to help the patient develop a more contented outlook toward life. Commonly, the patient and doctor meet for a psychotherapy session once or twice a week for several months. But sessions may occur more frequently or less frequently.

Sometimes groups of 4 to 12 patients participate in *group therapy.* By meeting as a group with the psychiatrist, the patients help each other understand themselves.

When working with a child, the psychiatrist may use *play therapy.* The child, instead of talking about his or her problems, acts them out with toys and games.

Two widely used forms of psychotherapy are *psychoanalysis* and *behavior therapy.* Psychoanalysis focuses on unconscious thoughts and feelings. According to psychoanalytic theory, the causes of many mental illnesses lie buried in the unconscious. The patient meets with the psychiatrist and talks about whatever comes to mind. The physician helps the patient understand his or her problems by uncovering the causes. Psychoanalysis may last for a number of years. See **Psychoanalysis.**

Behavior therapy aims to help patients change their behavior rather than help them understand why they act the way they do. Psychiatrists use *positive* and *negative reinforcement* to encourage patients to act in a healthier way. Using positive reinforcement, the psychiatrist praises or rewards the patient for "good" behavior. This

technique is considered more effective than negative reinforcement, which includes scolding the patient for "bad" behavior. Nancy C. Andreasen

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Abnormal psychology	Jung, Carl G.	Psychosis
Adler, Alfred	Menninger Clinic	Psychosomatic medicine
Freud, Anna	Mental illness	Psychotherapy
Freud, Sigmund	Neurosis	Sullivan, Harry S.
Horney, Karen	Psychoanalysis	
	Psychology	

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Psychical research, *SY kuh kuhl,* is the original name of a field of study that is now known as *parapsychology.* It involves the investigation and study of so-called *psychical* (mental) phenomena that are outside the field of normal psychology and the ordinary laws of behavior. Historically, psychical research focused on *spiritualism* (communication with the dead), the existence of ghosts, and fortunetelling. Modern interest is directed at *extrasensory perception (ESP)* and related phenomena. ESP is an awareness of something, such as another person's thoughts, without the use of the senses of hearing, sight, smell, taste, or touch.

Throughout history, there have been many reports and claims of psychical phenomena. Some can be neither verified nor disproved. Psychical research can provide a basis for an assumption that psychical phenomena exist, or it can expose false or fraudulent claims. But most scientists believe that the existence of such phenomena has not been proved. James E. Alcock

See also **Extrasensory perception; Clairvoyance; Parapsychology; Spiritualism; Telepathy.**

Psychoanalysis, *sy koh uh NAL uh sihs,* is a method of treating mental illness founded by the Austrian physician Sigmund Freud. Freud developed this treatment during the late 1800's and early 1900's. Other psychiatrists developed variations of his technique. The term *psychoanalysis* also refers to the theories on which such treatment is based.

According to Freud, a number of mental disorders could be cured by uncovering a patient's unconscious wishes and fears. He believed that behavior is influenced by instincts, fears, and unconscious mental processes not controlled by rational thought. He claimed that early childhood bodily experiences, including sexual ones, shape an individual's behavior in later life.

Psychoanalysts believe that unpleasant experiences, especially during childhood, may become buried in the unconscious mind and, together with inborn tendencies, may cause mental illness. Psychoanalytic treatment tries to bring these experiences out of a patient's unconscious mind and into the conscious mind.

Psychoanalytic treatment generally lasts for two to five years with sessions three to five times a week. The patient is instructed to reveal all thoughts as they occur. This is called *free association.* The patient and the analyst attempt to understand the psychological meaning of the ideas, fantasies, dreams, and behaviors that are expressed. During the course of the treatment, patients often transfer strong feelings they have for other people to the therapist. This process is called *transference.* Transference reveals certain attitudes acquired by patients in early life that have continued to interfere with their relationships with other people. By interpreting this transference, the therapist attempts to help patients achieve greater maturity and freedom in their relationships. Today, variations of psychoanalysis that involve much briefer and less intense treatments are much more commonly practiced.

Psychoanalytic theory. Freud taught that people do not say or do anything accidentally. Unconscious mental activity causes such "accidents" as slips of the tongue—for example, calling a person by the wrong name without realizing it—or forgetting an appointment. According to Freud, the mind experiences more unconscious than conscious activity.

Freud divided the mind into three parts: (1) the *id,* (2) the *ego,* and (3) the *superego.* Babies are born with an id, a group of instincts within the unconscious. As children grow, they develop an ego and a superego. The ego governs such areas as memory, voluntary movement, and decision making. The superego enables the mind to tell right from wrong. Severe conflicts between two of the parts may cause emotional problems. Difficulties might arise, for example, if the id produces strong desires to do things, but the superego insists that such desires are wrong.

Freud believed that children grow through a series of five overlapping stages of what he called *psychosexual development.* These stages are (1) the *oral phase,* (2) the *anal phase,* (3) the *phallic stage,* (4) *latency,* and (5) *adolescence.* During the oral phase, infants find pleasure in sucking. During the anal phase, which lasts to about age 4, children enjoy controlling the discharge of body wastes. Then, in the phallic stage, they become increasingly aware of their sex organs. They also develop an *Oedipus complex,* a strong attraction to the parent of the opposite sex. While in elementary school, children move into the less emotional latency period. Adolescence involves a struggle between childish feelings of dependency and adult longings for independence.

Emotional problems during any of the five stages, according to Freud, can cause characteristics of that stage to last into adulthood. A disturbed boy, for example, might remain unconsciously in love with his mother and jealous of his father even as an adult. Allen Frances

Related articles in *World Book* include:

Abnormal psychology	Fromm, Erich	Oedipus complex
Catharsis	Jones, Ernest	Psychiatry
Ego	Jung, Carl G.	Psychology
Erikson, Erik H.	Libido	Psychosis
Freud, Sigmund	Mental illness	Psychotherapy
	Neurosis	

Additional resources

Gaylin, Willard. *Talk Is Not Enough: How Psychotherapy Really Works.* Little, Brown, 2000.

Schwartz, Joseph. *Cassandra's Daughter: A History of Psychoanalysis.* Viking Penguin, 1999.

Psychodrama. See **Role playing.**

Psychological warfare, *SY kuh LAHJ uh kuhl,* uses propaganda to reach certain goals. It can be used before a war to deter fighting, or during a war to win it. A nation uses psychological warfare to convince its poten-

tial enemies that they cannot possibly win, and that they should not start to fight. During a war, it uses psychological warfare to convince enemy troops that their cause is unjust and hopeless. Its goal is to destroy the enemy's will to fight. Joel Slackman

See also **Propaganda; World War II** (The secret war).

Psychology is the scientific study of mental processes and behavior. Psychologists observe and record how people and other animals relate to one another and to the environment. They look for patterns that will help them understand and predict behavior, and they use scientific methods to test their ideas. Through such studies, psychologists have learned much that can help people fulfill their potential as human beings and increase understanding between individuals, groups, nations, and cultures.

Psychology is a broad field that explores a variety of questions about thoughts, feelings, and actions. Psychologists ask such questions as: "How do we see, hear, smell, taste, and feel? What enables us to learn, think, and remember, and why do we forget? What abilities are we born with, and which must we learn? How do our abilities change as we grow older? How much does the mind affect the body, and how does the body affect the mind? For example, can we change our heart rate or temperature just by thinking about doing so? What can our dreams tell us about our needs, wishes, and desires? Why do we like the people we like? Why are some people bashful and others not shy at all? What causes violence? What is mental illness, and how can it be treated?"

The research findings of psychologists have increased our understanding of why people behave as they do. For example, psychologists have discovered much about how personality develops and how to promote healthy development. They have some knowledge of how to help people change bad habits and how to help students learn. They understand some of the conditions that can make workers more productive.

A great deal remains for psychologists to discover. Nevertheless, insights provided by psychology can help people function better as individuals, friends, family members, and workers.

Psychology and other sciences

Psychology is closely related to the natural science of biology. Like many biologists, psychologists study the abilities, needs, and activities of human beings and other animals. But psychologists focus on the workings of the nervous system, especially the brain.

Psychology is also related to the social sciences of anthropology and sociology, which deal with people in society. Like anthropologists and sociologists, psychologists investigate the attitudes and relationships of human beings in social settings. These three academic disciplines often study the same kinds of problems from different perspectives. However, psychologists concentrate on individual behavior. They are especially interested in the beliefs and feelings that influence a person's actions.

In addition, psychology is similar to a medical field called *psychiatry*. Most psychologists have an M.A. or Ph.D. degree and may or may not specialize in the treatment of psychological disorders. Psychiatrists, on the other hand, have an M.D. degree and devote themselves to treating psychological disorders.

Methods of psychological research

In their research, psychologists use much the same approach as other scientists do. They develop theories, also called *hypotheses,* which are possible explanations for what they have observed. They then use scientific methods to test their hypotheses. The chief techniques used in psychological research include (1) naturalistic observation, (2) systematic assessment, and (3) experimentation.

Naturalistic observation involves watching the behavior of human beings and other animals in their natural environment. For example, a researcher might study the activities of chimpanzees in the wild. The psychologist looks for cause-and-effect relationships between events and for broad patterns of behavior.



Group therapy enables psychologists to counsel several individuals at one time. In such a group, people who face similar challenges meet to share experiences and learn from one another. The group setting encourages members to provide social and emotional support for the other members.

Psychologists conducting such studies try to observe a group large enough and typical enough to accurately reflect the total population. Such a group is called a *representative sample.* Observers also attempt to keep their personal views from influencing the study. In addition, psychologists try to prevent their presence from affecting the behavior being observed. A careful scientist hides from sight or remains on the scene long enough to become a familiar part of the environment.

Naturalistic observation is a valuable source of information to psychologists. The research itself has less effect on the subjects' behavior than a controlled experiment does. But observation alone seldom proves a cause-and-effect relationship between two or more events. As a result, psychologists use naturalistic observation chiefly as an exploratory technique to gain insights and ideas for later testing.

Systematic assessment is the general name for a variety of organized (systematic) methods used to examine (assess) people's thoughts, feelings, and personality traits. The chief types of systematic assessment include case histories, surveys, and standardized tests.

A *case history* is a collection of detailed information about an individual's past and present life. Nearly all clinical psychologists gather case histories of their patients to help them understand and treat the patients' problems. A psychologist who notices similar experiences or patterns of thought in several case histories may gain insight into the causes of certain emotional disorders.

A *survey,* sometimes in the form of a *public opinion poll,* is a study that measures people's attitudes and activities by asking the people themselves. Surveys provide information on attitudes and behaviors, such as political views or consumer buying habits, and many other topics. A psychologist conducting a survey prepares carefully worded questions. The researcher may interview participants personally or mail questionnaires to them. If the psychologist wishes to form general conclusions, the survey must collect responses from a representative sample of individuals.

A *standardized test* is an examination for which average levels of performance have been established and which has shown consistent results. In addition, uniform methods of administering and scoring the test must have been developed. Psychologists use standardized tests to help measure abilities, aptitudes, interests, and personality traits. For example, most students who plan to attend college take a standardized test called a *college entrance examination* during their junior or senior year in high school. This test measures some of the abilities thought to contribute to a student's success in college.

Still other tests, called *projective tests,* yield clues to a person's inner feelings. In a Rorschach test, for example, the subject describes what he or she sees in a series of inkblots. In the Thematic Apperception Test, the subject invents a story about the characters in each of a series of pictures. Psychologists can interpret responses on these tests as expressions of an individual's personality.

Case histories, surveys, and standardized tests enable psychologists to gather much information that they could not detect by naturalistic observation. However, the accuracy of the information gathered from such sources depends on well-designed studies and on truthful, complete responses from the individuals who participate.

Major fields of psychology

Abnormal psychology deals with psychological disorders and disturbed individuals. For example, researchers might investigate the causes of violent or self-destructive behavior or the effectiveness of procedures used in treating an emotional disturbance, such as depression.

Biological psychology examines the relationship between behavior and body structures or functions, particularly the workings of the nervous system. Biological psychologists explore the functions of the brain, how hormones affect behavior, and the physical processes involved in emotions, sensory experiences, and *cognition* (the process by which people acquire knowledge, solve problems, and make plans).

Clinical psychology uses the understandings derived from developmental and abnormal psychology to diagnose and treat psychological disorders and adjustment problems. Some clinical psychologists work to develop programs for the prevention of emotional illness or conduct basic research on how individuals can better cope with the problems of daily life.

Cognitive psychology explores the way people acquire, store, and retrieve information. Psychologists in this field might try to understand why people forget, or they might study the mental steps people use to solve problems.

Counseling psychology helps people adjust to changes in their lives or lifestyles. Counseling psychologists may help people make career decisions, deal with personal or relationship problems, or stop destructive behaviors, such as smoking or chronic overeating.

Developmental psychology studies the physical, cognitive, and social changes that occur across the life span of human beings. Many developmental psychologists specialize in the study of children or adolescents. Gerontology, a related field, focuses on physical, psychological, and social experiences and changes among older adults.

Educational psychology aims to improve teaching methods and materials, to solve learning problems, and to measure learning ability and educational progress. Researchers in this field may devise achievement tests, develop and evaluate teaching methods, or investigate how children learn at different ages.

Evolutionary psychology examines how genes respond to natural selection to produce particular traits or behaviors. Researchers in this field might try to explain differences in sexual or social behavior between men and women in terms of natural selection experienced by prehistoric human beings.

Industrial psychology is concerned with people at work. Industrial psychologists investigate such matters as how to make jobs more rewarding or how to improve workers' performance. They also study personnel selection, leadership, and management. Organizational psychology is a related field.

Perception, in psychology, is the study of how an organism becomes aware of objects, events, and relationships in the outside world through its senses. Psychologists in the field of perception analyze such topics as vision, hearing, taste, smell, touch, and movement.

Personality refers to the characteristics that make individuals different from one another and account for the way they behave. Personality psychologists investigate how an individual's personality develops, the chief personality types, and the measurement of personality traits.

Social psychology studies the social behavior of individuals and groups, with special emphasis on how behavior is affected by the presence or influence of other people. Social psychologists concentrate on such processes as communication, political behavior, formation of attitudes, and development of relationships.

Experimentation helps a psychologist discover or confirm cause-and-effect relationships in behavior. In a typical experiment, the researcher divides subjects at random into two groups. One group is called the *experimental group,* and the other is called the *control group.* For the experimental group, the researcher changes conditions that will likely affect the subjects' behavior and holds all other factors constant. The experimenter does nothing to the control group. If the experimental group behaves differently from the control group, the changed conditions probably caused the difference in behavior.

Other experiments involve repeated testing of the same subjects under different conditions. For example, a study might test how alcohol affects people's driving. Each subject would take a driving test on a laboratory simulator while sober and then repeat the test after drinking a prescribed amount of alcohol. Any difference in performance would probably be due to the alcohol consumed.

The experimental method enables scientists to test a theory under controlled conditions. But many psychologists hesitate to form conclusions based only on laboratory investigations. In many cases, people's behavior changes simply because they know they are part of an experiment.

History

Beginnings. Since ancient times, philosophers and people in general have wondered why human beings and other animals behave as they do. The origins of psychology are often traced to the ancient Greek philosopher Aristotle, who was chiefly interested in what the human mind could accomplish. Aristotle believed that the mind or soul, which the Greeks called the *psyche,* was separate from the body. He thought the psyche enabled people to reason and was the source of the highest human virtues. The word *psychology* comes from the Greek words *psyche* (mind or soul) and *logia* (study).

During the Middle Ages, scholars studied behavior chiefly from a religious rather than a scientific viewpoint.



Cognitive psychologists may study the mental abilities of animals to learn about the development of the human mind. Here, a chimpanzee recognizes its own reflection in a mirror. This may indicate that chimpanzees are self-aware, much like people.

However, several philosophers of the 1600's and 1700's made contributions to the development of psychology. René Descartes, a French philosopher, described the body and mind as separate structures that strongly influenced each other. He suggested that the interaction between body and mind took place in the pineal gland, a tiny organ in the brain.

Descartes also believed that people were born with the ability to think and reason. This doctrine, called *nativism,* was rejected in the late 1600's and early 1700's by a group of philosophers called *empiricists.* These thinkers, including Thomas Hobbes and John Locke of England, David Hume of Scotland, and George Berkeley of Ireland, believed the mind is empty at birth. They thought that knowledge of the outside world comes only through the senses, and that ideas result from people's experiences in life.

Psychology becomes a science. In the mid-1800's, two German scientists—the physiologist Johannes P. Müller and the physicist and physiologist Hermann L. F. von Helmholtz—began the first systematic studies of sensation and perception. Their work showed that the physical processes underlying mental activity could be studied scientifically.

But psychology did not develop into a science based on careful observation and experimentation until the late 1800's. The American philosopher William James founded the first psychology laboratory in the United States and wrote the first psychology textbook, *Principles of Psychology* (1890). A similar laboratory was established in Germany by Wilhelm Wundt. Wundt, a philosopher trained in medicine and physiology, also edited the first journal of experimental psychology. The work of James and Wundt marked the beginning of psychology as a distinct field that was separate from philosophy.

From the late 1800's until the 1930's, psychologists were divided about what they should study and how they should study it. Four major schools developed. These schools were (1) structuralism, (2) behaviorism, (3) Gestalt psychology, and (4) psychoanalysis.

Structuralism grew out of the work of James, Wundt, and their associates. These psychologists believed the chief purpose of psychology was to describe, analyze, and explain conscious experience, particularly feelings and sensations. The structuralists attempted to give a scientific analysis of conscious experience by breaking it down into its specific components or structures. For example, they identified four basic skin sensations: warmth, cold, pain, and pressure. They analyzed the sensation of wetness as the combined experience of cold and smoothness.

The structuralists primarily used a method of research called *introspection.* In this technique, subjects were trained to observe and report as accurately as they could their mental processes, feelings, and experiences.

Behaviorism was introduced in 1913 by John B. Watson, an American psychologist. Watson and his followers believed that observable behavior, not inner experience, was the only reliable source of information. This concentration on observable events was a reaction against the structuralists' emphasis on introspection. The behaviorists also stressed the importance of the environment in shaping an individual's behavior. They

chiefly looked for connections between observable behavior and stimuli from the environment.

The behaviorist movement was greatly influenced by the work of the Russian physiologist Ivan P. Pavlov. In a famous study, Pavlov rang a bell each time he gave a dog some food. The dog's mouth watered when the animal smelled the food. After Pavlov repeated the procedure many times, the dog's saliva began to flow whenever the animal heard the bell, even if no food appeared. This experiment demonstrated that a response—such as the flow of saliva—can become associated with a stimulus other than the one that first produced it—in this case, the sound of a bell instead of the smell of food. The learning process by which a response becomes associated with a new stimulus is called *conditioning.*

Watson and the other behaviorists realized that human behavior could also be changed by conditioning. In fact, Watson believed he could produce almost any response by controlling the rewards and punishments in an individual's environment.

During the mid-1900's, the American psychologist B. F. Skinner gained much attention for behaviorist ideas. In his book *Walden Two* (1948), Skinner describes how the principles of conditioning might be applied to create an ideal planned society.

Gestalt psychology, like behaviorism, developed as a reaction against structuralism. Gestalt psychologists believed that human beings and other animals perceive the external world as an organized pattern, not as individual sensations. For example, a motion picture consists of thousands of individual still pictures, but we see what looks like smooth, continuous movement. The German word *Gestalt* (pronounced *GUH SHTAHLT*) means *pattern, form,* or *shape.* Unlike the behaviorists, the Gestaltists believed that behavior should be studied as an organized pattern rather than as separate incidents of stimulus and response. The familiar saying "The whole is greater than the sum of its parts" expresses an important principle of the Gestalt movement.

Gestalt psychology was founded about 1912 by Max Wertheimer, a German psychologist. During the 1930's, Wertheimer and two colleagues brought the Gestalt movement to the United States. For more information, see Gestalt psychology.

Psychoanalysis was founded during the late 1800's and early 1900's by the Austrian physician Sigmund Freud. Psychoanalysis was based on the theory that behavior is determined by powerful inner forces, most of which are buried in the unconscious mind. According to Freud and other psychoanalysts, people *repress* (force out of conscious awareness) any desires or needs that are unacceptable to themselves or to society. The repressed feelings can cause personality disturbances, self-destructive behavior, or even physical symptoms.

Freud developed several techniques to bring repressed feelings to the level of conscious awareness. In a method called *free association,* the patient relaxes and talks about anything that comes to mind while the therapist listens for clues to the person's inner feelings. Psychoanalysts also try to interpret dreams, which they regard as a reflection of unconscious drives and conflicts. The goal of psychoanalysis is to help the patient understand and accept repressed feelings and find ways to deal with them.

Modern psychology has incorporated many teachings of the earlier schools. For example, though many psychologists disagree with certain of Freud's ideas, most accept his concept that the unconscious plays a major role in shaping behavior. Similarly, most psychologists agree with the behaviorists that environment influences behavior and that they should study chiefly people's observable actions. However, many psychologists object to pure behaviorism. They believe that it pays too little attention to biological and cognitive processes.

A school called *humanistic psychology* developed as an alternative to behaviorism and psychoanalysis. Humanistic psychologists believe individuals are controlled by their own values and choices and not entirely by the environment, as behaviorists think, or by unconscious drives, as psychoanalysts believe. The goal of humanistic psychology is to help people function effectively and fulfill their own unique potential. The supporters of this approach included the American psychologists Abraham H. Maslow and Carl R. Rogers.

A group of psychologists known as the *cognitive school* believe there is more to human nature than a series of stimulus-response connections. These psychologists concentrate on such mental processes as thinking, reasoning, and self-awareness. They investigate how a person gathers information about the world, processes the information, and plans responses.

Other psychologists are interested in the biological processes related to behavior and *cognition* (the process by which people acquire knowledge, solve problems, and make plans). *Neuroscientists* study how processes in the brain and nervous system create individual experiences associated with thoughts, emotions, and senses. *Behavioral geneticists* look for links between genes and behavior or personality.

The *sociocultural perspective* recognizes the role of the social and cultural environment in cognition and behavior. Psychologists working from this perspective view even themselves as subject to the cultural and historical context in which they live.

Many psychologists do not associate themselves with a particular school or theory. Instead, they select and use what seems best from a wide variety of sources. This approach is called *eclecticism.*

Careers in psychology

Most individuals who become psychologists begin by earning a bachelor's degree in psychology at a college or university. Some jobs in psychology require only a bachelor's or master's degree. But, for the broadest range of career opportunities, a psychologist needs a doctoral degree. Most individuals who plan to become clinical psychologists also serve at least a year as an *intern* at a psychological clinic. Psychology interns treat patients, but they work under the supervision of experienced therapists.

Many psychologists work for educational institutions, including colleges, universities, and public school systems. Most psychologists at such institutions combine several interests by teaching, conducting research, and serving as counselors or therapists. Many other psychologists hold jobs in hospitals, clinics, mental health centers, government agencies, research organizations, con-

sulting firms, or business companies. Still others are self-employed.

In the United States, a person who plans to have a private practice as a psychologist must be licensed by the state. Most states require that such a person have a doctoral degree. The chief professional organizations for psychologists in the United States are the American Psychological Association (APA) and the American Psychological Society (APS). Deborah South Richardson

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Allport, Gordon W.	James, William
Ames, Adelbert, Jr.	Jung, Carl
Bettelheim, Bruno	Köhler, Wolfgang
Binet, Alfred	Maslow, Abraham H.
Clark, Kenneth B.	Pavlov, Ivan P.
Ellis, Havelock	Piaget, Jean
Erikson, Erik H.	Rogers, Carl R.
Freud, Anna	Skinner, B. F.
Freud, Sigmund	Thorndike, Edward L.
Fromm, Erich	Thurstone, Louis L.
Hall, G. Stanley	Watson, John B.
Harlow, Harry F.	Wundt, Wilhelm
Horney, Karen	Yerkes, Robert M.

Major fields of psychology

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Other related articles

Behavior	Psychoanalysis
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Psychopathology. See **Abnormal psychology.**

Psychosis, *sy KOH sihs,* is a term used to describe a severe mental illness. Psychoses are characterized by a variety of symptoms that most people consider abnormal. These include *hallucinations,* such as hearing voices when no one is around, and *delusions,* such as the notion that one is being persecuted or conspired against (see **Hallucination; Delusion**).

Some psychoses have obvious physical causes. For example, the brain may be diseased as the result of an infection such as *general paresis,* which is caused by syphilis. Or, a physical illness of another part of the body may affect the brain, as in delirium due to pneumonia. These are called *organic psychoses.* In *toxic psychoses,* a harmful or poisonous substance (toxin) affects the brain. An example of this is a psychosis caused by lead poisoning.

Other psychoses have no obvious physical cause. The most common psychosis is *schizophrenia* (see **Schizophrenia**). Nancy C. Andreasen

See also **Mental illness.**

Psychosomatic medicine, *sy koh soh MAT ihk,* is the use of the methods and principles of psychology in the treatment of physical ailments. The term is taken from the Greek words *psyche,* which means *mind,* and *soma,* which refers to the body.

Doctors have long known that emotional disturbances affect a person's body. For example, when a person is afraid or angry, epinephrine flows into the blood, increasing the action of the heart. Certain mental conflicts may make a person more susceptible to disease, or cause what appears to be a disease.

Bodily disorders that historically have been thought to be related to emotional disturbances include asthma, *peptic ulcers* (stomach or duodenal ulcers), *rheumatoid arthritis* (inflammation and stiffness of the joints), *neurodermatitis* (chronic skin disorders), and *hypertension* (high blood pressure). However, this concept is losing popularity among doctors.

Psychosomatic medicine usually is not considered a special field of medicine. Most medical doctors have had some training in psychology and psychiatry. They often use psychological methods along with other methods of treatment. Some patients need help from doctors who specialize in psychiatry. Paula J. Clayton

Psychotherapy, *sy koh THEHR uh pee,* is any treatment of mental or emotional disorders by psychological means. Most psychotherapy is based on discussions between a therapist and one or more patients.

There are three principal types of psychotherapists: (1) psychiatrists, (2) psychologists, and (3) psychiatric social workers. Psychiatrists have an M.D. degree and advanced training in the diagnosis and treatment of psychological disorders. Psychiatrists are the only psychotherapists permitted to prescribe tranquilizers and other drugs as part of the treatment. Most psychologists have a Ph.D. degree and practical training in psychology. Most psychiatric social workers have a master's degree and training in techniques of psychotherapy. In addition, psychiatric nurses may play a role in psychotherapy.

Psychotherapy includes a wide range of techniques based on different ideas and theories about the causes of psychological disorders. Some psychotherapists use one form of therapy for all their patients. However, many therapists vary their techniques to suit the nature of the patient's problems. Scientists disagree over how much psychotherapy can accomplish for troubled individuals, but most agree that it can be helpful. There is no evidence that one form of therapy is more effective than any other. Much depends on the experience, skill, and warmth of the therapist, and on the relationship he or she establishes with each patient.

Most techniques of psychotherapy may be classified according to three general approaches: (1) analytic, (2) behavioral, and (3) humanistic. There are other forms of psychotherapy that cannot be classified in any of these main categories. A psychotherapist who uses any approach may also use a technique called *group therapy.*

Analytic psychotherapy. The best-known type of analytic psychotherapy is *psychoanalysis,* a method of treatment developed by the Austrian physician Sigmund Freud. Psychoanalysis is based on the theory that psychological disorders are caused by conflict between conscious and unconscious influences. For example, an individual's sex drives may conflict with his or her moral standards. According to psychoanalysts, people develop methods called *defense mechanisms* to deal with conflicts that they cannot resolve. Perhaps the most common defense mechanism is *repression,* the forcing of unpleasant feelings or painful memories from the conscious part of the mind into the unconscious part. The goal of psychoanalysis is to bring repressed conflicts to conscious awareness. The patient may then be able to understand the conflicts and deal with them.

Psychoanalysts use several techniques to penetrate a patient's defense mechanisms. For example, Freud developed a method called *free association,* in which the patient relaxes and talks about anything that comes to mind. The therapist listens for clues to the individual's unconscious motives. Psychoanalysts also try to interpret dreams, which they regard as a source of symbolic clues to important unconscious feelings and conflicts. In addition, these therapists investigate the patient's life history, especially childhood memories.

There are a variety of methods of analytic psychotherapy other than psychoanalysis. For example, major variations of Freud's ideas and techniques were developed by Alfred Adler of Austria, Erich Fromm and Karen Horney of Germany, and Carl Jung of Switzerland. However, all analytic therapists focus on the interplay between the conscious and unconscious mind.

Behavioral psychotherapy is based on the concept that psychological problems result from a basic learning process called *conditioning.* In conditioning, a person learns to make specific responses to stimuli from the environment. According to behavioral theory, individuals who have psychological problems either have failed to learn effective responses to stimuli or have learned faulty behavioral patterns in dealing with stresses.

Behavioral therapists attempt to change a patient's self-defeating behavioral patterns by a variety of means. For example, the therapist may reward desirable responses and ignore or punish any other responses. Behavioral therapists also work to change patients' beliefs about themselves and their behavior. The therapist may try to increase a person's confidence in his or her own ability to function effectively. The therapist also may try to help a patient develop more reasonable goals.

Humanistic psychotherapy emphasizes people's potential for growth and self-fulfillment rather than concentrating on their unconscious conflicts or their self-defeating behavior. Humanistic therapists work to help patients develop personal awareness, self-understanding, and an appreciation of their own worth. The therapist does not probe the patient's past life, as a psychoanalyst does, or attempt to change specific behavior, as a behavioral therapist does. Instead, the therapist provides an atmosphere of acceptance and support where the patient can explore his or her problems.

There are several types of humanistic psychotherapy. The most typical one is probably *client-centered therapy,* which was developed by the American psychologist Carl R. Rogers. Rogers thought the word *patient* implied illness, and so he referred to the person seeking help as a *client.* Client-centered therapy assumes that the troubled individual is the best expert for solving his or her own problems. The therapist repeats and restates the client's feelings and thoughts in an effort to help the person gain insight. The therapist does not try to explain the problem or tell the client what to do. According to Rogers' theory, clients can learn to make constructive choices by becoming more aware of their emotions.

Other forms of psychotherapy include (1) Gestalt therapy, (2) transactional analysis, and (3) reality therapy. Gestalt therapy, developed by the German psychiatrist Frederick S. Perls, is directed at bringing patients' thoughts and actions into harmony with their deepest feelings. In transactional analysis, the therapist helps patients analyze their relationships in family and social situations. In reality therapy, the patient is held responsible for his or her own behavior and is forced to accept its consequences.

Group therapy is psychotherapy conducted with a group of patients, usually from 4 to 12. Any approach to psychotherapy may be applied in a group setting. For example, there are psychoanalytic therapy groups, behavior therapy groups, and Gestalt groups. Group therapy has several advantages. A therapist can serve more people in a group than in individual sessions, and they can share experiences and learn from one another. The group also provides social and emotional support to its members in times of stress.

In *family therapy,* one or more therapists work with the members of a family as a group. The therapists also may hold meetings with individual family members. Family therapists believe that even if only one family member seems to have a problem, all the members are involved in some way.

William M. Smith

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Mental illness
Neurosis
Psychiatry
Psychoanalysis
Rogers, Carl R.

Psychrometer. See Hygrometer.

Psyllium, *SIHL ee uhm,* is an herb grown chiefly in France, Spain, and India. There are several species of the herb. Psylliums grow as high as 2 feet (60 centimeters) and have leaves that look like grass. The plants have many small white flowers, which are arranged in spikes. Psylliums bear a seed that is used in medi-



WORLD BOOK illustration by John F. Eggert

Psyllium

cines because of its laxative qualities. One species, *Plantago ovata,* is used in some breakfast cereals.

Some medical researchers believe that seeds from *P. ovata* may help lower the level of cholesterol in a person's bloodstream. Some cereal companies have added the seeds from this plant to their products and have used the medical claim in advertisements. Doctors consider people with high cholesterol levels at high risk of having a heart attack. The United States Food and Drug Administration (FDA) has not confirmed psyllium's effect on cholesterol levels. The FDA also fears that too much psyllium in a diet could cause health problems.

Richard C. Keating

Scientific classification. Psyllium plants belong to the plantain family, Plantaginaceae.

PT boat was one of the smallest, fastest, and most maneuverable fighting ships of the United States Navy. The letters PT stood for *patrol torpedo,* which meant that the craft carried out patrol duties and also carried torpedoes for combat. PT boats were often called *mosquito boats,* because they "stung" the enemy with great speed, and were most deadly in the dark.

In World War II, which the United States entered in 1941, PT boats made a remarkable record. They destroyed over 250,000 long tons (254,000 metric tons) of Japanese shipping. General Douglas MacArthur, his wife and child, and various officers and statesmen fled from the Bataan Peninsula to the island of Mindanao in PT boats in March 1942, on their journey from the Philippines to Australia. Future President John F. Kennedy was awarded the Navy and Marine Corps Medal for heroism and leadership after the boat he commanded, *PT-109,* was sunk by a Japanese destroyer in 1943.

PT boats were taken from the active list in 1959. However, in 1962, two boats had their torpedo tubes removed to increase their speed. These boats were put back on the active list as *PTF boats* (patrol torpedo boats, fast). The Navy acquired 24 other PTF boats between 1962 and 1968. Most of these ships saw service in the Vietnam War throughout the 1960's. They were later replaced by newer and smaller types of patrol craft. No PTF boats remain in the Navy today.



National Archives

The U.S. Navy PT boat was a speedy patrol craft. These boats won fame during World War II for attacks on Japanese shipping.

The PT boats used in combat by the Navy during World War II measured 77 to 80 feet (23 to 24 meters) long and about 20 feet (6 meters) across at their widest part. They were powered by three supercharged gasoline engines, each capable of 1,250 to 1,500 horsepower (930 to 1,120 kilowatts). The boats could reach up to 43 knots (nautical miles per hour). PT boats carried crews of 12 to 17 men.

PT boat hulls were basically different from those of other warships. They were called *planing* hulls because they skimmed or planed on the water surface. Larger ships cut through the water and will not rise up on the surface. They have *displacement* hulls.

PT boats, although much larger than high-speed, outboard-motor runabouts, had similar hulls. They were broad beamed, with a shallow *V*-shaped bottom. This design made PT boats of little use in rough or choppy water. Their high rate of fuel consumption limited their range. PT boats carried small, multipurpose guns, and sometimes rockets, in addition to torpedoes. Their most efficient use was restricted and the Navy kept few on active duty in peacetime. Jack Sweetman

See also **Torpedo.**

PTA. See **National Congress of Parents and Teachers; Parent-teacher organizations.**

Ptarmigan, *TAHR muh guhn,* is the name of a group of birds that live in northern parts of the Northern Hemisphere, such as Alaska, the Aleutian Islands, and Greenland. A ptarmigan can be recognized by the covering of short feathers on its feet. These feathers help it to travel across the snow. In winter, its feathers are white, and the bird often hides in snowbanks for protection. In summer, its feathers are reddish-brown and black. Ptarmigans build their nests on the ground. The nest is lined with grass or leaves. The females lay from 4 to 15 eggs. The eggs may be cream colored or red and are covered with black or dark brown spots.

Three kinds of ptarmigans live in North America. They are the *white-tailed ptarmigan,* the *rock ptarmigan,* and the *willow ptarmigan.* The white-tailed ptarmigan lives in the Rocky Mountains from central Alaska to New Mexico. The rock ptarmigan lives in the Arctic from the Aleutian Islands to Greenland. The willow ptarmigan makes its home in the Arctic, in the Canadian provinces of British Columbia and Newfoundland and Labrador, and in northern Europe and Siberia. The willow ptarmigan is the state bird of Alaska (see **Alaska** [picture: The state bird]). Bertin W. Anderson

Scientific classification. Ptarmigans belong to the subfamily Tetraoninae in the family Phasianidae. North American ptarmigans are genus *Lagopus.* The white-tailed ptarmigan is *L. leucurus;* the rock is *L. mutus;* and the willow is *L. lagopus.*

See also **Bird** (pictures: The ptarmigan hides from enemies; Birds of the Arctic).

Pteranodon. See **Pterosaur.**

Pteridophyte, *TEHR uh duh fyt* or *tuh RIHD uh FYT,* is one of a large and important group of plants that are simpler in their structures than flowering plants. The name *pteridophyte* means *fern plant.* Not all the pteridophytes are ferns, but ferns are the best known of the group.

The pteridophytes lack flowers, but they have many of

the same tissues and habits that flowering plants have. Their organs are distinctly divided into roots, stems, and leaves, as those of flowering plants are.

Instead of reproducing by seeds as flowering plants do, the pteridophytes multiply by means of very small bodies called *spores* (see **Spore**). These spores do not result from flowers, but grow on special parts of the plant in little capsules. The spore capsules of ferns are the roundish, brown specks on the back of certain of the fern leaves. When the spores drift away and begin to develop, they produce small plants quite different from the ferns. After a time these small plants give rise to young ferns, which grow and produce another generation of spores. This process is known as *alternation of generations* (see **Alternation of generations**).

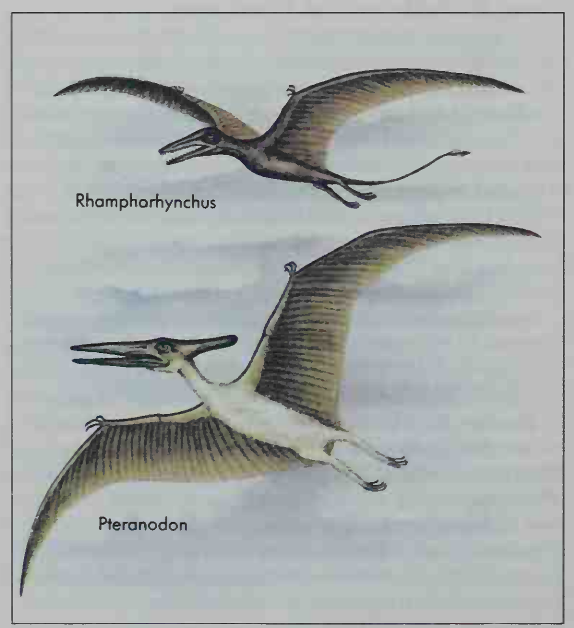
Other plants that belong to the pteridophyte group include horsetails, club mosses, and ground pines. These pteridophytes have a life history that is similar to that of the ferns.

Millions of years ago the pteridophytes were among the largest and most common kinds of plants. Many of the world's coal deposits contain large amounts of pteridophyte remains. Fossil records show that many pteridophytes reached the size of large trees. But present-day kinds, except the tree ferns of the tropics, are small, nonwoody herbs. David H. Wagner

See also **Club moss; Fern; Horsetail.**

Pterosaur, *TEHR uh sahr,* was a member of an extinct group of flying reptiles. Pterosaurs lived in the Mesozoic Era, from about 248 million to 65 million years ago. Their fossils have been found on every continent.

There were two major kinds of pterosaurs—*rhamphorhynchoids* and *pterodactyls.* Rhamphorhynchoids developed first. They had a short face and neck and a long tail. This group included some of the smallest pterosaurs, which were about the size of sparrows. Pterodactyls were more advanced and varied in size.



WORLD BOOK illustration by Oxford Illustrators Limited

Pterosaurs were prehistoric flying reptiles.

They had a long face and neck, and were almost tailless. The *Pteranodon,* a large pterodactyl, had a crest at the back of the head. The largest known flying animal was a pterodactyl. Its wingspan ranged from 36 to 39 feet (11 to 12 meters).

At one time, experts believed that pterosaurs flew poorly and used their wings only for gliding. Most scientists now think pterosaurs were good fliers that flapped their wings up and down. Only some of the larger and more specialized forms seem to have been suited chiefly for soaring and gliding. Pterosaurs had light, hollow bones. Three clawed fingers and a long fourth finger extended from the end of each forelimb. Each wing consisted of a membrane that stretched from the side of the body to the tip of the fourth finger. Fine, parallel fibers prevented the wing from tearing. Fur may have covered the pterosaur's body and kept the animal from losing body heat. Pterosaurs may have been able to run on their hind legs, but probably they were clumsy on land.

Pterosaurs ate other animals. The smaller forms probably ate insects. Some of the larger pterosaurs fed on fish, lizards, and other small *vertebrates* (animals with backbones). Keith Stewart Thomson

See also **Fossil** (picture: A fossil *Pterodactylus*).

Ptolemy, *TAHL uh mee* (A.D. 100?-165?), was one of the greatest astronomers and geographers of ancient times. He was also known as Claudius Ptolemaeus. Almost nothing is known about his life. But scholars have determined that he made his astronomical observations in Alexandria, Egypt, about A.D. 150. Ptolemy's observations and theories are preserved in a 13-part work entitled *Mathematike Syntaxis,* or *Mathematical Composition.* This work was so admired that it became known as the *Almagest,* meaning *the greatest.*

In the *Syntaxis,* Ptolemy rejected the idea that the earth moves. He pointed out that the earth is spherical and claimed that everything in the universe moves either toward or around the earth's center. For example, heavy objects fall in straight lines toward the earth's center. And, according to Ptolemy, the moon, sun, planets, and stars move around the earth at various rates of speed. Ptolemy believed that the stars were fixed points of light in a rotating sphere. Against this background of stars, Ptolemy traced the motions of the planets and worked out a theory for each of them. He stated that the planets are much closer to the earth than the stars, but are farther away than the moon. Ptolemy developed his system of astronomy largely from the ideas of the Greek astronomer Hipparchus (see **Hipparchus**).

Ptolemy's system of astronomy was accepted as authoritative throughout Europe until 1543. That year, the Polish astronomer Nicolaus Copernicus formulated his theory that the earth is a moving planet. Copernicus showed that Ptolemy's system was based on questionable assumptions and arguments (see **Copernicus, Nicolaus**).

Ptolemy devoted two parts of the *Syntaxis* to a catalog of the stars. He described a mathematical arrangement of the stars and gave the celestial latitude and longitude, as well as the *magnitude* (brightness), for each of them. This catalog included 1,022 stars grouped into 48 constellations. Ptolemy also discovered the irregularity of the moon in its orbit.

Ptolemy dealt with certain technical aspects of astronomy in his other writings. His serious treatment of astrology helped to spread belief in astrology as a scientific field. In his *Optics,* Ptolemy provided an extensive treatment of light and vision. He also dealt with reflection from various types of mirrors and studied the *refraction* (bending) of light as it passes from one medium to another.

Ptolemy's *Geography* opens with an excellent theory of map projection. The book lists places with their longitudes and latitudes. It also contains a map of the world, including Europe, northern Africa, and most of Asia, as well as 26 maps of specific areas. Ptolemy exaggerated the land mass from Spain to China and underestimated the size of the ocean. This mistake encouraged Christopher Columbus to make his famous voyage in 1492.

A. Mark Smith

See also **Astronomy** (Earth-centered theories); **Map** (Ancient maps; picture: An early map of the world).

Ptolemy I, *TAHL uh mee* (367?-283? B.C.), founded a family of rulers who reigned in Egypt from 323 to 30 B.C. This family became known as the Ptolemies. Ptolemy I, who took the title of king of Egypt about 305 B.C., ruled until 285 B.C.

Ptolemy was born in Macedonia, a region north of Greece. He became a leading general in the army of Alexander the Great, a Macedonian king who built an empire that included Egypt and most of western Asia. After Alexander died in 323 B.C., Ptolemy gained control of Egypt. He extended his rule to the island of Cyprus, Judea (in the southern part of ancient Palestine), and Cyrene, a Greek colony in northern Africa.

Ptolemy helped Egypt become a strong, independent country. He introduced new crops and improved existing ones. He encouraged trade and regulated imports and exports. Ptolemy recruited Greek and Macedonian settlers for his army, navy, and administration. He gave the settlers land and encouraged the development of Greek culture in Egypt.

Ptolemy founded a museum and library in Alexandria that helped make the city one of the world's great centers of culture and learning. Ptolemy also founded the cult of the god Serapis, which combined Greek and Egyptian practices (see **Serapis**). Donald Engels

PTSD. See **Post-traumatic stress disorder.**

Pu Yi, *poo yee* (1906-1967), often called Henry Pu Yi, was the last emperor of China. In 1912, when he was 6 years old, he gave up the throne after a revolution overthrew his Manchu government and established a republic. Pu Yi was allowed to remain in Beijing, the capital. But in 1924, he fled from warlords to Japanese protection in the nearby city of Tianjin. In 1931, the Japanese seized a large part of northeastern China and made it a puppet state called *Manchukuo.* In 1934, they made Pu Yi ruler of Manchukuo. He ruled until the end of World War II in 1945. The Soviets captured him and turned him over to the Chinese Communists, who pardoned him in 1959. Pu Yi was born in Beijing. Arif Dirlik

Puberty. See **Adolescent.**

Public accountant. See **Accounting.**

Public assistance. See **Welfare.**

Public defender is an official paid by the state to defend people who are accused of a crime and are too poor to hire their own lawyer. Criminal defendants have a constitutional right to such legal representation and must be informed of that right when they are arrested. Most public defenders have only criminal jurisdiction.

The first public defender was appointed in Los Angeles County, California, in 1914. Public defenders are fairly common today, but many courts appoint local, private attorneys called *assigned counsel,* who often must serve without pay to defend the poor. Jack M. Kress

See also **Court** (How courts work).

Public domain is a legal category that covers government-owned land as well as creative works that the public may use freely. The creative works that may fall in the public domain include any scientific, artistic, or literary creation or invention. Such works are also called *intellectual property.* This article focuses on intellectual property that is in the public domain. For more information on public-domain land, see **Public lands.**

When intellectual property is in the public domain, anyone can use, make, or sell it without paying royalties or becoming liable in a lawsuit. Laws governing such property are, by treaty, the same in almost all countries.

All intellectual property begins as *proprietary material* —that is, material owned exclusively by a person or company. Different types of intellectual property enter the public domain in different ways. A chemical, mechanical, or electrical invention enters the public domain if it is sold or publicized and no patent application is filed within a year. If patented, the invention passes into the public domain when the patent expires. Copyrighted material enters the public domain when its copyright runs out. A trademark passes into the public domain if its use has been permanently discontinued or if the trademark has become widely used as a generic term. David Pressman

See also **Copyright; Patent; Trademark.**

Public finance. See **City government; Local government; National budget; Taxation.**

Public health is the general health of all members of a community. The term also refers to a community's efforts to prevent and cure illness and maintain the health of its people.

The governments of many nations have established public health agencies. The functions of these agencies vary from country to country, depending on the nation's level of technological development and its specific health problems. In addition, international health organizations conduct research and work to solve public health problems throughout the world.

In the United States, agencies of the federal, state, and local governments take part in public health programs. The federal government supervises public health care through the agencies of the Public Health Service (PHS), a division of the Department of Health and Human Services. All the state governments and many local governments have a department of health or department of human resources that administers public health work. Voluntary health agencies and private health foundations also contribute to the field of public health. This article discusses chiefly the work of state and local public health departments in the United States.

Functions of public health agencies

Public health agencies in the United States care for the medical needs of individuals and also provide health



Alan Kaleta, Gamma/Liaison

Preventing disease is an important goal of public health agencies. Health department officials often vaccinate children against measles, polio, and other contagious diseases.



Jack Fields, Photo Researchers

Ensuring environmental safety is a part of public health. All states try to control air, water, and soil pollution. These officials are taking water samples to test for contamination.

services for the general community. Most communities are served by their local health department. The Public Health Service mainly assists state and local health agencies. It conducts research, provides scientific information, and works to combat unsafe foods and drugs and contagious diseases.

The functions of state and local public health departments vary with the needs of the communities served. A typical state health department has various divisions, each of which handles a different aspect of health care. The principal functions of these divisions include (1) health planning, (2) providing preventive family or personal health care services, (3) ensuring environmental safety, (4) inspection and licensing, (5) collecting vital statistics, (6) furnishing support services for health workers, and (7) supplying disaster services.

Health planning. The health planning division of a state health department figures out the proper use of services, personnel, and facilities in certain areas. Such uses depend on the needs of communities in those areas. Officials determine these needs on the basis of such factors as infant and overall death rates and *communicable disease* rates. Communicable diseases can be spread from person to person, and many communicable diseases may lead to epidemics if they are not controlled.

Providing preventive health care services is a state responsibility for people with special health problems. These individuals include infants and children, pregnant women, and the poverty-stricken. State health departments give them such preventive services as immunizations, programs that supply information about nutrition and general health care, and control of communicable and *chronic* (long-lasting) diseases.

A state may contract with local health officials or private nonprofit agencies to deliver preventive health services. The state also may arrange for certain individuals to be served by health centers operated by the federal, state, or local government. Some of these centers aid people who have psychiatric problems or are victims of drug abuse.

Ensuring environmental safety. State health departments have regulatory agencies that establish and enforce standards for housing, food quality, and control of environmental pollution. Some states combine all such agencies into one division, which may be called the Bureau of Environmental Hazards. This division also carries out rodent- and insect-control measures designed to prevent the spread of diseases carried by the pests.

Inspection and licensing. Public health departments enforce state and local ordinances that require inspection and licensing of health facilities to ensure proper care of patients. Such facilities include hospitals, clinics, nursing homes, and research laboratories. Health departments also regulate pharmacies.

Collecting vital statistics involves gathering and storing records of such human events as births, marriages, divorces, and deaths. These records also cover



Mike Keza, Gamma/Liaison

A public health laboratory helps public health centers and private physicians identify diseases and other health hazards. This technician is examining food for signs of food poisoning.

certain causes of death, including accidents and diseases. Vital statistics tell health officials what has happened in a community regarding all these matters and what is likely to happen. See **Vital statistics.**

Furnishing support services for health workers. Most state health departments maintain laboratories that help public health centers and private physicians detect communicable diseases. These laboratories work with the Centers for Disease Control and Prevention, an agency of the Public Health Service, in fighting the spread of disease. State health departments also support research programs and distribute health education materials to medical professionals and the public.

Supplying disaster services. In many states, the public health department coordinates the services needed when natural disasters and other emergencies occur. Such calamities include floods, tornadoes, hurricanes, and major airplane or railroad accidents. Each state has a basic disaster plan to ensure medical services, housing, pure water, sewage disposal, and communications in stricken areas. In some cases, a state may receive help from the American Red Cross, the Federal Emergency Management Agency, or other organizations that specialize in disaster management.

History

Public health problems began when people first established communities. Many ancient civilizations had methods of handling such matters as waste disposal, disease control, and the need for pure water. However, epidemics struck most societies.

More than 2,000 years ago, the ancient Greeks did much to safeguard the health of the people. For example, large cities hired physicians to provide medical care. But most health measures benefited only the upper classes and did little to help the poor.

After the Romans colonized Greece during the 100's B.C., they adopted many health care techniques of the Greeks. For example, the Romans assigned public physicians to towns, primarily to care for the poor. They also built water pipes, supplied pure water, and established hospitals.

Following the fall of the Roman Empire in the A.D. 400's, most European communities ignored public health. Many communities finally established public health programs during the 1800's after suffering numerous epidemics.

The United States paid little attention to public health until 1866, when a cholera epidemic struck the nation for the 18th consecutive year. The American Public Health Association was founded in 1872. In 1893, threatened by another cholera epidemic, New York City established the first U.S. public health laboratory based on the new science of microbiology. Many states and cities then built similar laboratories to fight epidemics of such diseases as diphtheria, tuberculosis, dysentery, typhoid fever, and scarlet fever.

Careers

Public health offers a wide variety of career opportunities. People trained for administrative responsibilities or as medical professionals, such as physicians and nurses, hold about half the positions in this field.

Most public health work requires a master's degree. Such professionals as public health nurses and nutritionists must have a graduate degree in their specialties. Most people who work in environmental health have a master's degree from an engineering or technical school. They specialize in such areas as air pollution, industrial hygiene, and general environmental protection. Physicians hold many administrative positions in public health. These positions are also open to people with a graduate degree in business administration, health services administration, public administration, or a similar field. Gwynne Roeseler Winsberg

Related articles in *World Book* include:

American Lung Association
Bill of health
Centers for Disease Control and Prevention
Disease (Preventing disease)
Drug Enforcement Administration
Environmental pollution
Federal Emergency Management Agency
Health
Health, Board of
Health and Human Services, Department of
Health Council, National
Immunization
Malnutrition
Nursing (Community health nurses)
Public Health Service
Pure food and drug laws
Sanitation
Waste disposal
Water (City water systems)
World Health Organization

Additional resources

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Public Health Service (PHS) is a division of the United States Department of Health and Human Services. It includes eight primary agencies: the Health Resources and Services Administration; the National Institutes of Health; the Food and Drug Administration; the Centers for Disease Control and Prevention; the Substance Abuse and Mental Health Services Administration; the Indian Health Service; the Agency for Toxic Substances and Disease Registry; and the Agency for Health Care Policy and Research. These agencies work with state and local agencies, educational and research institutions, and private industry to conduct health research, control disease, and provide health information, education, and services. The PHS also works with other nations and international agencies toward solving global health problems.

The assistant secretary for health directs the PHS. Other top officials include the surgeon general of the United States, who promotes good public health techniques. The federal government began a health service for merchant sailors in 1798. This agency was formally established in 1870 as the Marine Hospital Service. It became the Public Health Service in 1912.

Critically reviewed by the Public Health Service

Related articles. For more information on agencies of the Public Health Service, see **Health and Human Services, Department of,** and **National Institutes of Health.** See also:

Food and Drug Administration
Health, Board of
Pure food and drug laws
Surgeon general of the United States

Public housing. See Housing (Low-income and assisted housing); **Housing and Urban Development, Department of.**

Public lands include all the territory owned by a national government. The United States government owns about 762 million acres (305 million hectares) of land, or about a third of the land area of the country. Most of the public lands are in the western part of the nation, with the largest amount in Alaska. Congress may use or dispose of it in whatever way it feels will best serve the public interest.

Public lands are divided into (1) public-domain lands and (2) acquired lands. *Public-domain lands* have never been privately owned. They are what remains of the land acquired by the U.S. government from the 13 original states and from other nations. *Acquired lands* are lands the federal government has acquired from private owners and from state and local governments. Much of the land was purchased for such purposes as government buildings and defense installations. About 703 million acres (281 million hectares) of U.S. public lands are lands in the public domain, and about 59 million acres (24 million hectares) have been acquired.

The government reserves some of the public lands for military and naval installations, reclamation projects, wildlife refuges, federal buildings, and national cemeteries, forests, monuments, and parks. The term *public lands,* however, commonly applies to land that the government will lease or sell to private individuals. It does not include land that has been set aside for national parks and other uses. Since the United States became a nation, more than 1 billion acres (400 million hectares) of public land have been sold, granted to homesteaders, or otherwise turned over to private owners.

Management of public lands

Most of the public lands in the United States are administered by the Bureau of Land Management in the Department of the Interior. But many other federal agencies, including the Department of Agriculture and the Department of Defense, have jurisdiction over some public land. The Bureau of Land Management occasionally sells some of its land at public auction or trades it for land that connects other public lands.

In surveying public lands, the government divides an area into units of 36 square miles (93 square kilometers), called *townships.* Each township is further divided in a checkerboard fashion into 36 sections of 1 square mile (2.6 square kilometers). Each section, containing 640 acres (259 hectares), is divided into quarter sections of 160 acres (65 hectares). To help locate and describe any particular piece of land, surveyors use certain meridians of longitude (north-south lines), called *principal meridians,* and certain parallels of latitude (east-west lines), called *base lines.* All townships lying in a line from north to south are described as a *range.* See **Westward movement** (The Ordinance of 1785; illustration).

History

Acquisition of public lands. Between 1781 and 1786, the federal government gained control over a large area west of the Allegheny Mountains and north of the Ohio River. Four eastern states had claimed all or part of this region during the colonial period. By 1802, other seaboard states ceded what is now the states of Alabama and Mississippi.

The purchase of Louisiana in 1803 almost doubled the size of the United States. Other important additions of territory include the acquisition of Florida in 1819, the annexation of Texas in 1845, the acquisition of Oregon in 1846, the cession by Mexico of a vast territory between Texas and the Pacific Ocean in 1848, the Gadsden Purchase in 1853, the purchase of Alaska in 1867, and the annexation of Hawaii in 1898. Almost all this land became part of the United States' public lands. Texas and Hawaii retained control of the public lands within their borders, because they had been independent nations.

Disposal of public lands. As early as 1783, land companies tried to purchase public lands for the purpose of establishing settlements in the area north of the Ohio River. Their actions forced Congress to formulate a policy for the disposition of public lands. In the Ordinance of 1785, Congress adopted policies intended to produce revenue and encourage compact settlement. The ordinance also established a permanent method for surveying. The land policies expressed in this law represented the views of Easterners, and soon proved unpopular in the West. Under pressure from Western members of Congress, later land laws permitted purchasers to buy a specified minimum amount of land at a low price. The laws encouraged pioneers to buy and settle on any public lands that had been surveyed.

An important development in land policy came in 1862, with the passage of the Homestead Act. It provided that people who lived on public lands for five years and made certain improvements might acquire title to 160 acres (65 hectares) through the payment of very small fees. This law made it possible for workers in Eastern cities to move west and own farms of their own.

Individual settlers were not the only people interested in obtaining grants of public land. Land companies and speculators bought large tracts of land to sell to people who wanted new homes in the West. After 1850, corporations and individual promoters tried to gain control of large acreages for grazing, mining, logging, or control of other natural resources. Such groups acquired much of the public land in the Far West.

The government also used the public lands to promote certain of its own objectives. It offered free land to veterans of every war from the American Revolutionary War through the Mexican War. It granted land to the states for the support of public education. The Morrill Act of 1862 gave to each state an amount of land in proportion to its population for the establishment of agricultural colleges (see **Land-grant university**). The government also gave generous grants of land to railroads along proposed rights of way to encourage railroad building west of the Mississippi River.

By 1890, nearly all the good farmland had passed into private ownership. But private owners acquired large amounts of other land under the Homestead Act until the mid-1930's. In 1976, the U.S. government ended the homesteading program in all states except Alaska. It expired there in 1986.

Dennis L. Thompson

Related articles in *World Book* include:

Conservation (Conservation in the United States)
Homestead Act
Land Management, Bureau of
National cemetery
National forest
National Park System
Squatter's rights

Public law. See Law (Branches; Law in the 1900's).

Public library. See Library.



Eve Arnold, Magnum

Public opinion can help bring about various reforms by putting pressure on government leaders. The protesters shown at the left are calling for an end to the production of nuclear arms.

Public opinion refers to the opinions or views of people in a community or country on issues of public interest or concern. Such issues may deal with any subject that is open to differing beliefs and attitudes. For example, it is a matter of *opinion* whether the nations of the earth should attempt to cooperate in some sort of international organization, and, if so, what form this organization should take. In matters of opinion, reasonable people may hold widely different viewpoints.

On the other hand, it is no longer considered to be merely a matter of opinion that the earth is a sphere rotating on an axis and revolving in an orbit around the sun. It is a matter of *fact,* which can be demonstrated and about which reasonable people do not differ.

When a problem affects a number of people, they will discuss it and argue about it. These activities help develop a common opinion, or *consensus.* When discussion is open or public, these matters are public opinions. Public opinion, in this sense, varies widely in its character and content. Public opinion may be merely the variety of individual opinions in the early stages of discussion, when issues are not sharply defined and people are not well informed about them. At other times, the opinions of many individuals may become similar enough to form a *majority opinion* or even a consensus, which determines the kind of action a group will take. A vote decided by the majority gives structure to the group opinion and makes it lawful.

There is no definite way in which public opinion affects the decision-making process of government leaders and groups. Elections of political leaders are one important way the public can express its judgment about a candidate. However, the process of shaping government policy is often slow and uneven. Expressions of opinion may influence politicians. But such expressions also may be disregarded because public opinion lasts only a short time, is emotionally charged, and usually represents the more visible and vocal portion of the population. The balance of the population, often called the *silent majority,* does not express its views as regularly or as visibly.

Nevertheless, one of the major concerns of a democratic society is to determine the extent and significance of the opinions held by individuals and groups. The most common technique today, the public opinion poll, is used to survey the opinions of a sample of the population. The accuracy of the results depends on the knowledge and skill of the pollsters in selecting the sample and in developing good interview questions. There is always some margin for error in the results.

There is no one "public"

A *public* is any group of people within which a controversy arises. They are the people who take part in the controversy and who are, or may be, affected by the way in which the controversy is finally settled. This group may be fairly stable or organized, such as the residents of a local community or the citizens of the United States. A public may also be made up of a number of individuals who are unorganized and hard to identify, but who for widely varied reasons have a common interest in the matter at issue. Sometimes a public may be so small and compact that discussion takes place almost wholly through conversation and speechmaking in face-to-face situations.

Today, however, when modern means of communication make vast numbers of people aware of controversial issues and common interests, publics tend to be large and impersonal. These publics involve people who are not known to one another and are widely distributed over the country, or even among a number of countries. The members of such publics rarely meet each other face to face or have much direct communication. They are held together by the press, radio, television, motion pictures, and other means of communication. These impersonal but powerful publics are numerous in today's highly complex society. Many of them have their own specialized means of communication—newspapers and magazines, sponsored radio and television programs, and local and national organizations representing opposing sides in controversies about issues.

The same person may be a member of several of these publics at one time. An individual may thus take

part in discussions on a number of different problems and develop opinions in one area that conflict with those held on other subjects. An opinion about some economic issue, for example, may not be wholly in agreement with other opinions about moral, religious, or political issues. Intense public controversies sometimes arise out of efforts to reconcile opinions about problems in one field with opinions in others.

The process of forming opinion

Many factors affect the position people will take on any public issue. People's values and attitudes influence the opinions they hold. Some people are well informed or make an effort to become so, and others make quick judgments based on casual impressions. Some people act quite independently. Yet other people are influenced mainly by the views of their friends and associates. Equally well-informed people often form differing opinions because they interpret facts differently, or because they have different interests, desires, anxieties, and prejudices.

Some individuals, especially celebrities, frequently have much more influence than others in the process of opinion formation. Such a person often appears to know all the facts and to have an outstanding ability to determine how they should be dealt with. Thus, this person may boldly and aggressively urge people to support a particular idea or course of action. Leadership may also be taken by unknown or ordinary people who, either as individuals or as small groups, spread their ideas slowly by word of mouth. In time, they can make a deep impression on the opinion of the masses of people.

Events also may have a great effect on the forming of opinion if they are dramatic enough, near enough, or personal enough to attract the attention of large numbers of individuals. The Great Depression of the 1930's focused public attention sharply on the need for economic reforms. Unemployment and widespread need changed more opinions than hundreds of lectures, radio talks, editorials, or sermons ever would have done. Various controversial topics quickly generate public opinion responses. Such topics include gun control, abortion, drug legislation, government authority, and foreign policy issues. Issues affecting war and peace are also a powerful force in influencing public opinion.

Agencies of public opinion

An agency of public opinion is simply the carrier of information about public issues, and of views about these issues. The agency may be an individual, a group of individuals, or a mechanical device that helps them to communicate with other people. An agency of public opinion is not necessarily its originator or maker, but it may be so.

The oldest agency of public opinion is what Walter Bagehot, an English publicist of the 1800's, called *common talk.* Ordinary conversation among friends and acquaintances on the street, in public meeting places, in homes, or elsewhere is still a powerful agency in forming public opinion. In early times, word of mouth was almost the only carrier of public opinion. It was only a step from friendly group discussions to the oration or the sermon, in which one person more skilled at thought and expression than the rest undertakes to organize and state the prevailing opinion on some particular issue or problem for the group.

The press. Speeches, books, and pamphlets were the principal means of expressing opinion until the 1800's. Then newspapers appeared in large numbers and soon developed wide circulations. The newspaper became more powerful than any other agency as a carrier of public opinion. Each newspaper usually builds its own group of readers who depend on it for news and opinion about public affairs. Its power within the public is great, but this power is limited by rival newspapers with other points of view. Magazines are also powerful in making public opinion.

The political cartoon is a powerful tool for expressing and molding opinion in the press. The cartoonist can caricature prominent people and ideas, and thus can often express a point of view more bluntly and much more vigorously than it could be expressed in writing. Most cartoons appeal more to the emotions than to reasoned and informed analysis.

The motion picture is another important agency of public opinion. It has the advantage of giving people a vivid and concrete presentation of people and events that otherwise could be known only through oral or printed reports. Audiences are introduced intimately to manners, customs, ideas, and ways of life that may be much different from their own. Many screenplays also express a point of view toward issues. Newsreels, travel pictures, documentary films, and other special kinds of motion pictures have been widely used to spread news and propaganda. The visual approach often affects the emotions of the audience and generates a strong response.

Radio and television carry the voices and words of newscasters and commentators—and of newsworthy people themselves—directly into millions of homes. They also bring into the home pictures of events as they occur. Radio and television have supplemented rather than replaced the newspaper and the motion picture as carriers of news and opinion. The older means of communication have time to give a more studied, fuller version of events than can the immediate reporting to which radio and television are best adapted.

Educational agencies. Schools and other educational institutions have great importance among the agencies of opinion. Their importance lies partly in their ability to develop basic attitudes and points of view that have a great bearing on the opinions people will form about the issues that arise from day to day. They provide knowledge about social, economic, political, and other aspects of life, and equip people with the skills necessary to interpret information about current developments.

Other agencies. The making of public opinion by special propaganda groups has by no means disappeared from modern society. The most important of these groups are those with political, economic, or religious interests. There are also less powerful groups that create ethical, nationalistic, racial, literary, artistic, and other types of public opinion. See **Propaganda.**

Political opinion is made for the most part by or for the political parties. Every large political party has an elaborate propaganda machine. Even the government in

power, whether local or national, feels obliged to create a public opinion favorable to itself so that its program may be carried out.

The making of public opinion by economic groups is also important in modern society. Business and economic institutions constantly seek to create and maintain a public opinion favorable to their interests. Businesses are especially active in the endeavor to sell more goods and services. In doing so, they use advertising, sales promotions, and public relations to create favorable public opinion toward their products and business itself. Labor groups, farmer groups, and even consumers themselves are often organized for the purpose of developing public opinion powerful enough to have substantial influence.

Public opinion and government

If people are going to live together in society, they must set up certain rules, regulations, and controls to give that society some permanent form. In this way, the society can carry on its life with little conflict or disorder. In a dictatorship, the controls set up are forced on the majority of the people by a small group who control the instruments of power. The people have little or no voice in deciding what kinds of controls are to be used. But in a democracy, the controls rest on the voluntary consent of at least a majority of the members of society.

In many early societies, and in some countries today, leaders have used force or violence to make the people accept the rules. In some cases, the mere threat of violence is enough. Some leaders have used fraud to deceive the people. To protect their people from fraud, governments have extended laws against this abuse to include unethical practices in medicine, advertising, selling, and other fields. See **Fraud**.

Propaganda and censorship are the most widespread governmental controls over public opinion. With propaganda, the government seeks to make people accept its program and policies by persuading them that only such a program will keep them out of danger, or win a war, or meet some other emergency. Propaganda is actually a means of creating public opinion, rather than simply controlling it. Censorship, which seeks to eliminate ideas and attitudes, is a negative control over public opinion. It is often coupled with *counterpropaganda,* designed to meet the threat of one particular idea with one more favorable to the government. See **Censorship; Propaganda.**

Democratic society requires the abandonment of the older, cruder, and less reasonable controls. Instead, an informed and intelligent public opinion is regarded as the best means of securing orderly conduct and cooperation among people. Public opinion becomes the ultimate controller of social goals, laws, and ways of life. Democracy as an ideal is government by an enlightened public opinion. The average person in any society recognizes that everyone must live up to certain rules in society in order that each person can live in peace and freedom. An individual with this point of view is likely to resist any individual or group that seems to be trying to gain an excessive share of control in the whole society. The spread of education and the development of the newspaper, radio, and television have made it possible for more people to learn more about issues and events in their society. People can then react effectively to these conditions and developments.

Controlling public opinion

There is little doubt that public opinion has the potential to be a powerful means of forming social behavior in the modern world. Every group ambitious to rule or to exploit the masses of the people attempts to capture and control public opinion.

Democracy depends on a balance of power of different groups rather than upon the power held by one or a few groups. Its basic controls will therefore be designed to secure for its citizens freedom to know the facts about public matters, to secure full and free public discussion, and to make public decisions effective.

In the United States, a number of such controls exist. For example, the Constitution provides for a careful system of checks and balances. The president is balanced by Congress and the Supreme Court. Congress is balanced by the president and the Supreme Court. The Supreme Court is balanced by the president and Congress. In addition, the framers of the Constitution realized that further safeguards were needed to protect the individual against any single group that might seize power. The first 10 amendments, known together as the *Bill of Rights,* were added to the Constitution as a further protection of the opinions, privileges, and opportunities of citizens (see **Bill of rights**).

One of these amendments assures freedom of speech, press, and assembly. This freedom has been jealously guarded throughout U.S. history. Congressional hearings, other public agencies, and private organizations also work to provide individuals and groups with the opportunity to present their views.

An effective and progressive democracy depends on an enlightened public opinion. The surest and most constructive development of public opinion is education, both in the schools and in other agencies of public opinion. The freedoms and liberties that a democratic society provides also impose a number of responsibilities on the citizens of a democracy. Citizens must see the relationships among their own individual welfare, the proposals of the government, the interests of special groups, and the goals of the nation as a whole.

Extensive and accurate information is democracy's greatest ally, just as it is the greatest enemy of antidemocratic forms of government. Such information helps people make sound, informed judgments. Then they will also find it easier to see through the aims and devices of those who attempt to manipulate public opinion for selfish interests rather than the public good.

Taylor Stults

See also **Advertising; Censorship; Propaganda; Public opinion poll; Public relations**

Additional resources

Erikson, Robert S., and Tedin, K. L. *American Public Opinion.* 6th ed. Longman Pub., 2001.

Mitchell, Susan. *American Attitudes.* New Strategist, published biennially.

Public opinion poll is a survey to find out the attitudes, beliefs, or opinions of a large number of people. The population covered may include millions of individuals. But only a small number of them are actually questioned. If they have been properly chosen, their opin-



WORLD BOOK photo by Steven Spicer

A public opinion poll measures people's attitudes about various issues. A personal interview conducted by a trained interviewer, *above,* is probably the most reliable method of polling.

ions will usually accurately reflect those of the entire group.

Public opinion polls ask many kinds of questions. For example, a poll before an election may ask people whom they plan to vote for and why. Other polls may ask people if they plan to buy a new car and what kind of car they want.

Polls are conducted throughout the world. But they are most frequently taken in developed countries with a democratic form of government.

Who uses polls?

Public opinion polls are used chiefly by five types of groups: (1) news media, such as newspapers, magazines, television, and radio; (2) politicians; (3) business companies; (4) government agencies; and (5) social scientists. These groups generally use polls that are taken by private polling companies, university research centers, or government agencies. Some groups conduct their own polls.

News media publish or broadcast the findings of public opinion polls. The major television networks and national newspapers conduct their own polls. Broadcasting stations and newspapers also subscribe to polls such as those conducted by The Gallup Organization and Louis Harris and Associates.

Politicians use polls to help them plan their election campaigns and keep track of their strength with the voters. Polls help elected officials make decisions by telling them how people feel about various problems and issues. Many political candidates and elected officials hire polling groups to conduct private polls for their own use.

Business companies use polls to help them manage their operations and sell their products. Large numbers of businesses study the various polls that appear in the news media. Some companies also subscribe to special polls taken by private polling companies. Many advertising agencies conduct *market research polls* that measure people's knowledge and opinion of a product.

Government agencies rely on polls for guidance in operating and evaluating their programs. Such polls ask people's opinions on educational programs, medical services, transportation, and other subjects.

Social scientists sometimes use polls when studying human behavior. A psychologist might conduct a poll among different age groups to study differences in attitudes between younger and older generations.

Conducting a poll

People who conduct public opinion polls are sometimes called *pollsters.* The work of pollsters involves five steps: (1) defining the goals; (2) selecting the *sample,* the individuals to be questioned; (3) designing the questionnaire; (4) interviewing the sample; and (5) analyzing the results.

Defining the goals involves deciding what a poll will seek to find out and whom it will question. A poll may ask people's opinions about certain economic, political, or social issues. It may study people's attitudes toward various events, individuals, or situations. The group of people from which the sample is selected is called the *population* or *universe.* A population may consist of everyone in a city, state, or some other area. On the other hand, it may include only a certain group, such as factory workers, homeowners, or teen-agers.

Selecting the sample. Pollsters select the sample so that every person in the population has as close to an equal chance to be included as possible. When polls are conducted by telephone, they select the sample using *random digit dialing.* In this technique, phone numbers are picked by chance from among the possible phone numbers in the geographical area being polled. In polls conducted through personal interviews, pollsters first divide the area to be surveyed into major geographic regions. Specific localities are then selected by chance.

Within these localities, the pollsters select various neighborhoods by chance. Interviewers then conduct several interviews in each of these neighborhoods. In both telephone and personal interviews, pollsters also choose which member of the household to interview on a random basis.

Designing the questionnaire. Pollsters ask two general types of questions—*closed* and *open.* A closed question asks the respondents to select their answers from two or more choices. An open question asks them to give their opinions in their own words.

Before pollsters conduct a poll, they sometimes assemble a *focus group* of about 10 people to discuss the issue the poll will examine. The group's comments help pollsters to understand the public's attitude toward the issue so that they can make up an effective questionnaire. Most pollsters then pretest the questionnaire on a small number of people. By pretesting, the pollsters can tell if the respondents understand the questions, and if the answers provide the kinds of information sought. They also find out if the order of the questions affects the way people answer them.

Interviewing the sample. Most pollsters question respondents directly, either in person or by telephone. Such questioning ensures that all, or almost all, the people are interviewed. Questioning respondents in person has two advantages. The first one is that the interviewer can be at least reasonably sure that the respondent understands the questions. The second advantage is that the interviewer can use cards or other displays that list the choice of possible answers.

Telephoning respondents is the fastest way to conduct a poll, and it is less expensive than personal interviews. Some polls involve questionnaires that are mailed to respondents. However, many people do not return these questionnaires, and so mail surveys are usually not reliable measures of how the entire population feels.

Analyzing the results. Computers help quickly tabulate the pattern of responses to pollsters' questions. The most common tabulation shows the percentage of respondents who answered each question in a certain way. Analysis of the results can show how strongly people feel about various subjects and whether their opinions have changed since a previous poll. It can also show what differences of opinion exist between different segments of the population and how attitudes on different subjects are interrelated.

Evaluating a poll

The reliability of a poll depends chiefly on the size of the sample and how it is drawn. Most national polls involve interviews with between 500 and 2,000 people, depending on the purpose of the poll. If scientific procedures are followed in selecting the sample, the pollster can calculate *sampling error.* Sampling error is expressed as a range—a certain number of percentage points—above and below the reported finding of the poll. It is the range of results that could be expected if an infinite number of similar samples were polled on the same question. Sampling error depends on the size of the sample, not the size of the population.

Questions that are not fairly worded can also affect a poll's reliability. In addition, polls that have been sponsored by individuals who have something to gain by a certain result should be regarded cautiously.

History

An early survey of public opinion was conducted in the United States in 1824. The *Harrisburg Pennsylvanian* asked voters in Wilmington, Delaware, who they thought would be elected president that year. On the basis of the poll, the newspaper predicted that Andrew Jackson would win. Jackson received more electoral votes than any of his three opponents, but did not get a majority. As a result, the election went to the House of Representatives, which elected John Quincy Adams.

Polls following scientific procedures were first used in 1935 with the experimental nationwide surveys of George H. Gallup and Elmo Roper. Another pollster, Archibald M. Crossley, began conducting scientific polling methods the following year. In 1940, the first academic center for the development of polling techniques was founded by Hadley Cantril at Princeton University.

In the mid-1930's, two inaccurate presidential polls demonstrated the danger of relying on mail surveys and quota sampling. In 1936, the magazine *Literary Digest* mailed out 10 million questionnaires concerning that year's presidential election. Two million questionnaires were returned. Based on these replies, the magazine predicted that Governor Alfred M. Landon of Kansas would defeat President Franklin D. Roosevelt. But Roosevelt won in a landslide, and Crossley, Gallup, and Roper correctly predicted his reelection. The *Literary Digest* poll was inaccurate chiefly because the questionnaires were mailed to people chosen from telephone directories and from lists of car owners. As a result, wealthy people were overrepresented in the sample.

In 1948, polls based on quota samples predicted that Governor Thomas E. Dewey of New York would defeat President Harry S. Truman. However, Truman won reelection in one of the greatest upsets in U.S. history. The polls failed for two chief reasons. The last polls taken were conducted too long before the election, and many voters probably changed their minds. Also, the pollsters' quota samples did not accurately represent the people who voted. After the 1948 election, most pollsters began to use probability sampling. This change, along with refinements in interviewing and other procedures, greatly increased the reliability of polls.

Since the 1970's, two special kinds of polls, called *tracking polls* and *exit polls,* have been widely used during elections. Tracking polls are conducted with small samples toward the end of an election campaign. Candidates use these polls to follow changes in their standing with voters. Exit polls are taken as people leave their voting places. The news media use the information collected in exit polls to help interpret the results of an election. Albert H. Cantril

See also **Gallup, George H.; Market research; Public opinion.**

Additional resources

Asher, Herbert B. *Polling and the Public: What Every Citizen Should Know.* 4th ed. Congressional Quarterly, 1998.
Gallup, George H., Jr., ed. *The Gallup Poll.* Scholarly Resources, published annually.
Gawiser, Sheldon R., and Witt, G. E. *A Journalist's Guide to Public Opinion Polls.* Praeger, 1994.

Public ownership. See Government ownership.

Public relations, often called *PR,* is an activity that uses communication to increase understanding between an organization or individual and one or more groups called *publics.* The term *public relations* is also applied to the profession responsible for handling such activities.

Corporations, educational institutions, entertainers, government agencies, labor unions, politicians, and religious groups are among those who use public relations. Their publics vary from employees and stockholders to entire communities and members of the media. Many organizations use public relations to gain the understanding of both their *internal public* (employees) and *external public* (customers).

Communication strategies range from simple news releases and fact sheets to sophisticated public relations campaigns featuring films, advertisements, speeches, and television appearances. Such communication is aimed at gaining the good will of the community.

The basis of any effective public relations campaign is public benefit. If an organization does not serve the needs of its publics, they will not support it. Public relations experts help organizations and individuals learn what their publics want and establish communication policies that reflect concern for the interests of those publics.

Public relations generally is practiced through (1) corporate public relations departments, (2) public relations firms or agencies, and (3) public information departments. In a corporate PR department, specialists handle PR activities only for that company. In PR firms, public relations practitioners carry out activities for several organizations or individuals, also called *clients* or *accounts.* Nonprofit organizations, such as colleges and government agencies, have public information departments that work to strengthen the organization's image and credibility.

Methods. Public relations focuses on two main activities, *research* and *communication.* Research is vital to public relations because organizations need to know their publics' opinions about them. What people think and why they have such opinions are important in helping management establish corporate and client policies and practices.

Public relations uses many research methods to obtain information. Researchers gather information on the many problems and opportunities facing a company, its industry, and the business community. They may also gauge public opinion to provide political candidates with issues to discuss during a campaign. Researchers also test PR campaign effectiveness and keep up with public relations techniques being developed by other companies or firms.

Communication between organizations or clients and their publics is an important part of public relations campaigns. However, the size and complexity of modern organizations makes direct communication with individuals almost impossible. Most organizations use mass-communication methods to reach their publics, often focusing their PR campaigns at groups of people who share a common interest.

PR professionals use four principal methods to communicate with their publics: *advertising, lobbying, publicity,* and *press agentry.* Advertising involves the use of paid, nonpersonal communication through such media as billboards, the Internet, mail, newspapers and other publications, radio, and television. Lobbying attempts to influence special publics, such as legislators. Publicity and press agentry involve promoting an organization or client by getting favorable media coverage.

Public relations professionals often detect possible breakdowns in communication by analyzing responses received from their publics. These responses may come directly, as in e-mail messages, letters, or telephone calls to an organization. The responses also may come indirectly, as when voters respond to a public relations campaign by casting their ballots for a candidate or when consumers respond by purchasing or refusing to purchase a product.

History. Some elements of public relations, such as informing and persuading, have been used throughout history. But public relations as it is known today began to take form during the early 1900's, after a period of rapid industrial expansion in the late 1800's. Upon the advice of public relations counselors, corporation leaders realized that the community's good will would benefit them. Business leaders also realized that successful public relations campaigns had helped the federal government and welfare agencies in winning approval for their programs. Corporations began to set up programs designed to win their publics' favor. Schools, hospitals, and other nonprofit organizations also saw the need for organized attempts to gain public support.

Public relations developed slowly until the mid-1900's. Since then, it has spread to nearly all corporate and nonprofit organizations. The growth and expansion of the mass media have tended to make public opinion more powerful than ever before. Today, an organization's internal and external publics are more accessible than ever to those who wish to reach them. This improved access is aided by the work of public relations.

Careers. Most public relations activities take place in business and industry. Colleges, labor unions, national associations, schools, and volunteer agencies also have public relations programs. An organization may have its own public relations department, or it may hire a public relations firm.

A college education best prepares a person for a public relations job. Employers seek people with degrees in English, journalism, or public relations. Many employers prefer applicants with backgrounds in fields related to the company's activities. People interested in public relations should be creative and able to express their thoughts clearly, both orally and in writing. Such a person also should possess good problem-solving abilities.

Don W. Stacks

See also **Advertising; Communication; Marketing; Propaganda; Public opinion.**

Public revenue is funds raised through taxation to pay the expenses of government. See **Income tax; Local government; National budget; State government; Taxation.**

Public school. See **Canada** (Education); **Education; School** (How schools operate); **United Kingdom** (Education).

Public service. See **Careers** (Community and social services); **Economics** (Public services).

Public speaking is the art or practice of making a speech before an audience. In group or club events, there are many opportunities to make speeches. People who speak effectively are likely to become leaders. Training in effective public speaking is a key part of training for leadership in any field of activity.

Speakers who have a specific purpose and are successful in attaining it are said to be *effective.* If they try to inform, they are effective when the members of their audience understand the facts. If they try to persuade members of the audience to agree to do something or to change their opinions, the speakers are effective when members of the audience decide to take the action or when they do change their minds. If speakers try to entertain the audience, they are effective when the audience shows by applause or laughter that they are enjoying the speech.

Approach to a speech

Speakers must consider four points: (1) their subject, (2) their audience, (3) themselves as speakers, and (4) their occasion.

Subjects. The speaker's direct and indirect experiences are the two general sources of speech subjects. *Direct experience* is knowledge obtained by actual participation in events. *Indirect experience* is knowledge obtained from radio, television, reading, and listening to other people. Speakers can usually make a more effective presentation with subjects from their direct experiences. Subjects should stimulate speakers to their best efforts. At the same time, they must appeal to the audience and be keyed to the knowledge and experience of the listeners.

Subjects may be divided into three types: those which *inform,* those which *persuade,* and those which *entertain.* All are important.

Some examples of *informative* subjects are:

Basic principles of computers
The feeding habits of snakes
How steel is made

Some examples of *persuasive* subjects are:

The 12-month school year should be adopted.
The United States should abolish the Electoral College and adopt a system to provide for the direct popular election of the President.
Capital punishment should be abolished.

Some examples of entertaining subjects are:

Do teachers have private lives?
Inventions that never worked
Pets as members of the family

Audiences. Speakers must consider the knowledge and the wants of their audiences. They should find out what the members of their audience already know about the subject. The problem of explaining the operation and maintenance of a new microwave oven to a group of electrical engineers is different from explaining it to people who know little about electricity.

The speaker who attempts to persuade an audience should know their attitudes or opinions. If speakers know beforehand that their audience is opposed to their proposal, then they know that they face a different problem from that of persuading a favorable audience.



WORLD BOOK photo by Dan Miller

A public speaker should stand erect and speak loudly enough to be heard comfortably by every member of the audience.

Speakers should also know whether the members of their audience want to hear about a subject. People usually listen only when they think the speaker's ideas will be of some benefit to them.

Speakers. The speaker's personality is probably the most important factor in influencing audiences. Speakers should consider how the audience will view them.

Occasions. Speakers should think carefully about the time and place of their speeches. Is the occasion appropriate for the subject they have chosen? The meeting of a sailing club would hardly be an appropriate occasion for a speech designed to sell household appliances. However, such a meeting would be appropriate for a speech designed to raise money for new sailboats.

Planning the speech

When speakers have given careful thought to their subject, their audience, their own personality, and the occasion, they are ready to plan the speech itself.

Purpose. Speakers should first select their general purpose. Do they wish to present factual information only, or to *inform?* Do they wish to change beliefs or actions, or *persuade?* Or do they wish to amuse, or to *entertain?* With their general purpose in mind, they should prepare a brief statement of their specific purpose. Examples of specific purposes are:

Informative. Tell a class how steel is made.

Persuasive. Convince an audience that Congress should propose a constitutional amendment to abolish the Electoral College and to provide for the direct popular election of the President.

Entertaining. Amuse a school assembly with a humorous look at the private lives of teachers.

The main ideas. The next step should be to select the main ideas, or main divisions, of the subject as stated in the specific purpose. In informative speeches, the main ideas should define the specific purpose by answering the questions *who*? *what*? *where*? *when*? *why*? and *how*? In persuasive speeches, the main ideas ought to be the principal reasons for the desired belief or action. In entertaining speeches, the main ideas should be the divisions of the subject that can be amusing to the audience.

Supporting material. After selecting the main ideas, speakers should choose supporting material. This includes such things as *description, narration, comparisons, examples, testimony, statistics, visual aids* (charts, diagrams, demonstrations, slides, maps, motion pictures, photographs, samples, or working models), and *repetition* (restatement of important ideas to increase the chance that they will be remembered). The selection of main ideas and supporting material completes the *body* (main part) of the speech.

Introduction. Speakers should next plan the introduction. This usually has two parts, the opening and the statement of the specific purpose. In the *opening,* speakers catch the attention of their audience and arouse interest in their subject. They can do this by telling a joke or story, or by providing a fact or statistic. They may refer to an event, or to the present occasion, place, or audience (with humor or congratulations). They may quote something or ask a question. In their *statement of specific purpose,* they tell the audience precisely what they intend to do in their speech and what value this topic has for the audience.

Conclusion. Next comes the preparation of a conclusion. In informative speeches, this part should be a summary of the main ideas and specific purpose. In persuasive speeches, the conclusion should combine a summary with a final appeal to the audience to accept the arguments offered. Entertaining speeches usually end on a point of great amusement, without any type of formal conclusion.

Outline. After all these steps, speakers should prepare an outline. Here is a sample outline for the subject, Congress should propose an amendment to the U.S. Constitution to abolish the Electoral College and to provide for the direct popular election of the President.

Introduction

I. Opening

The American patriot Thomas Paine said, "Those who reap the blessings of freedom must undergo the fatigue of supporting it." Yet Americans today seem little concerned that the method of electing a U.S. President is undemocratic. Unlike other elected officials, the President is not directly elected by the people. The people elect presidential electors who have been chosen by their political parties to represent their party's candidate in the election. The presidential electors, in turn, choose a President. Under this system, the United States has elected three Presidents whose closest opponents received more popular votes than they did. In fact, a candidate could become President by winning in only 11 states—the 11 most heavily populated ones. This could leave the people in 39 states without a voice in the election. As a citizen you must be concerned that your voice may be stilled.

II. Purpose

The procedures for electing the President have been set down in the Constitution. To change the system, the U.S. Congress should propose a constitutional amendment. Several plans have come before Congress. Of these plans, the direct popular election plan is the most democratic and uncomplicated method of choosing a President. Thus, Congress should propose an amendment to abolish the Electoral College and to provide for the direct popular election of the President.

Body

I. The present system no longer suits the needs of the voters.

A. Delegates to the Constitutional Convention in 1787 agreed on the Electoral College system partially on the grounds that the public was not sufficiently informed to select the best person for President.

B. However, modern communications permit citizens to follow current events from day to day in newspapers and magazines and on radio and television.

II. A direct vote system would be more democratic.

A. Each voter would have an equal voice in choosing the President. The votes of citizens in heavily populated states would not carry more weight than the votes of those in other states.

B. The candidate with the most popular votes would become President.

III. If no candidate received a majority of the votes, a direct vote system would reduce the chances of political deals and an electoral crisis.

A. The present system could give a third-party candidate the power to control the outcome of an election.

B. The present system may delay the election of the President for two months after the general election.

C. A direct vote system would eliminate the danger of an unpledged elector voting against the candidate of the elector's party.

Conclusion

The Electoral College system of electing a President has proven dangerous, outdated, and undemocratic. The only system that would correct these flaws is a direct vote system. Therefore, Congress should propose an amendment to abolish the Electoral College and to provide for the direct popular election of the President.

Delivering the speech

Speakers may deliver their talks directly from the outline, or they may use the outline as the basis for a written speech. Skilled speakers usually prefer to speak from the outline, without writing the whole speech down.

A speech that is delivered from an outline, without being memorized, is said to be delivered *extempore,* or *extemporaneously.* Extempore speeches should not be confused with *impromptu* speeches. These types of speeches are made without any previous preparation, often without notice.

If speakers are properly prepared, they should feel at ease in front of an audience. They should relax and speak in a natural voice. They should stand erect, make eye contact with individuals in the audience, and speak loudly enough to be heard easily. In addition, speakers should vary the pitch and volume of their voice and their rate of speech to avoid being singsong or dull.

James M. Copeland

For the history of public speaking, see the *World Book* article on **Oratory**. See also **Debate; Speech**; and the section *A Student Guide to Better Writing, Speaking, and Research Skills* in the Research Guide/Index, Volume 22.

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Public transportation. See Transportation (Public transportation).

Public utility is a company that provides an essential service to the public. Public utilities include firms that offer electric power, natural gas, telephone, telegraph, water, and sewerage services. Airlines, bus lines, railroads, and other transportation systems are also public utilities.

Most public utilities in the United States are privately owned. But in Canada and some European countries, a majority are owned by the government. Government ownership in the United States exists chiefly at the local level. For example, the governments of cities, towns, and counties own most airports and transit, sewage disposal, and water supply systems.

Most public utilities enjoy a certain amount of protection from competition. In the United States, this protection is granted by local governments and by local, state, and federal regulatory agencies. In a given geographical area, a protected utility often can provide a service more efficiently and at a lower price than could several companies competing with each other. Vigorous competition may result in higher prices because each competing company may have to buy the same type of expensive equipment while serving fewer customers than would be served by a single, protected company.

Government regulation. Public utilities that enjoy protection from competition must be regulated to ensure that they charge reasonable rates and provide adequate service to the public. Utilities are required by law to serve any customer who is willing to pay for service. In addition, the service provided must be safe. In the United States, utilities are regulated by commissions, primarily at the state and federal levels.

By law, utilities also have certain rights. For example, each is entitled to rates that cover its operating costs and yield a reasonable profit. If the profit is not high enough, the company will be unable to attract investors and maintain and expand its services to customers.

In the United States, federal commissions regulate utilities that provide services across state boundaries. For example, the Federal Energy Regulatory Commission regulates natural gas and oil pipelines and hydroelectric power plants. The Federal Communications Commission controls broadcasting as well as telephone and telegraph services. The Securities and Exchange Commission regulates the finances of companies that control electric power and natural gas utilities.

Other federal regulatory commissions in the United States include the Federal Aviation Administration, which establishes the rules that all planes must follow when flying in the United States; and the Nuclear Regulatory Commission, which regulates the production of nuclear energy. All 50 states, plus the District of Columbia, also have their own regulatory commissions.

History. Public utilities in the modern sense can be traced to early English *common law.* Common law designated certain activities as "peculiarly affected with the public interest." Included were activities of docks, inns, warehouses, ferries, and canal companies. At first, these activities were regulated by court decision only. Later, they were also regulated by legislation.

The Interstate Commerce Commission became the first U.S. government commission with regulatory powers in 1887. It regulated the rates and trade practices of companies that transported goods and people by train and, eventually, those that handled transport by motor vehicle and boat. By 1920, more than two-thirds of the U.S. states had set up regulatory commissions. Many federal utility commissions were set up after 1930.

Developments in the late 1960's and the 1970's forced many public utilities in the United States to struggle for financial survival. During those years, interest rates, fuel prices, and construction and other costs rose sharply. As a result, public utilities found it necessary to increase their rates by large percentages. In addition, the increased construction costs led to a slowdown in the building of new facilities and thus prevented some utilities from providing adequate levels of service. Rates for electricity also rose because new federal regulations required electric power plants to install millions of dollars worth of pollution control equipment. Pressures by the public, by commercial and industrial groups, and by the federal government to limit utility rate increases in time helped lead to financial problems for many utilities. The financial position of utilities also worsened because of a new emphasis on conservation.

By the mid-1970's, many people in the United States had come to believe that public utilities could operate more efficiently if they were subject to less regulation. As a result, Congress began to significantly reduce regulation. Legislation passed in 1976 and 1980 granted railroad companies greater freedom in pricing and in abandoning unprofitable services. The Airline Deregulation Act of 1978 phased out federal control of fares and routes in the passenger airline industry. The Motor Carrier Act of 1980 increased competition in the trucking industry by allowing trucking firms greater freedom in setting rates. Deregulation in the natural gas industry led to the elimination by 1990 of price controls on all natural gas sold in the United States. Beginning in the 1980's, lower inflation and moderate fuel prices led to an improved financial position for most public utilities.

In the telephone industry, competition increased in 1984, when a federal lawsuit forced AT&T to give up its local telephone companies. At the time, AT&T dominated both local and long-distance telephone service in the United States. By the late 1990's, some states had begun taking steps to allow for increased competition among providers of electric power. Charles F. Phillips, Jr.

Related articles in *World Book* include:

City government
Federal Aviation Administration
Federal Communications Commission
Franchise
Local government
Monopoly and competition
Telephone (The telephone industry)

Publicity. See Advertising; Motion picture (Distribution); Public relations.

Publishing is the process of preparing, manufacturing, and distributing books, magazines, newspapers, or other materials in printed or electronic form. This article describes book publishing. For information on magazine and newspaper publishing, see **Magazine** and **Newspaper**.

Book publishing is a relatively small industry. But beyond its size, publishing has enormous importance in the educational and cultural life of society. Books are a living record of human history and knowledge. They have been the basic means of passing along the essential data of civilization from generation to generation. In addition, books provide pleasure and relaxation for many people.

The person or group who directs the business of publishing a book is called the *publisher.* A publisher is responsible for obtaining and editing the manuscript of the author or authors. The publisher supervises the printing and binding of the manuscript, and distributes it to the public. Most of the work is performed in a company called a *publishing house.* A publishing house may have hundreds of employees working in large office buildings, or it may consist of only one person who does all the work in a single room.

People have made and sold books since ancient times. For a description of the development of book publishing, see **Book** (History).

Kinds of book publishing

Publishing can be divided into three areas, each based on a specific type of book. The areas are generally known as (1) trade books, (2) educational books, and (3) reference books.

Trade books are books intended for the general reader. These books include novels; picture books for children; biographies; books on current affairs, history, or psychology; travel guides; cookbooks; and "do-it-yourself" books.

Trade publishers distribute most of their books through bookstores and the book departments of other stores. Some trade publishers also distribute books through *book clubs,* which people join to get certain selected books, usually at reduced prices.

Educational books are published by special publishers or by educational departments of trade publishers. These books are the textbooks used for instruction in schools and colleges. Educational publishers often employ teachers and educators to plan and write their textbooks. To keep information in classrooms current, educational publishers regularly produce updated editions of the textbook. Educational publishers sell some of their books directly to buyers in school systems. In addition, these publishers distribute their books through college bookstores.

Educational publishing is probably the most profitable area of book publishing. A great number of teachers and students are required to buy certain textbooks for their classes. A successful textbook can sell millions of copies over many years. Many publishers use the profits from educational books to publish trade books that may have uncertain sales prospects.

Reference books include encyclopedias, dictionaries, almanacs, and similar books that contain information about a wide variety of topics. The material is organized so that the user can find facts quickly and easily. Most reference book publishers hire specialists to serve either as authors for the topics or as consultants for general areas of knowledge.

The production of reference books can be expensive, especially if the works consist of several volumes. But many of these books have large sales to libraries, where people go to look up information. Reference books are also sold to individuals and families who want to have sources of information readily available. Some reference publishers use sales representatives who demonstrate and sell the books in the home.

Since the early 1990's, an increasing amount of reference material has been published in electronic form. This *electronic publishing* involves storing a large volume of information on a *CD-ROM* (*C*ompact *D*isc *R*ead-*O*nly *M*emory) or other device. The information can then be accessed quickly using a computer. It may also include such *multimedia* features as sound and video clips. Some publishers make certain materials available on the Internet, the global computer network.

Publishing a book

An author's manuscript goes through several stages of preparation before it reaches the reader in book form. Most publishers follow the same basic steps.

Acquiring the manuscript. Some authors of manuscripts hire *literary agents* to represent them. An agent first tries to find a suitable publisher for the manuscript. The agent then helps negotiate the author's financial arrangements with the publisher. In addition, some agents make deals allowing parts or all of the book to appear in magazines or as television or motion-picture adaptations. For these services, the author pays the agent 10 to 15 percent of the author's income from the book.

Most publishing houses employ editors who have the responsibility of acquiring manuscripts for publication. They will watch for likely subjects and authors, and negotiate the purchase with both authors and agents. They discuss the terms by which the company will produce and market the book.

The publisher signs a written contract with the author specifying the *advance* and *royalties.* An advance is a sum of money that the publisher, in effect, loans to the author while the book is in preparation. The advance is subtracted from the royalties, which are payments that the publisher makes to the author from profits gained from the sale of the book. The publisher pays the author a certain percentage of the price of the book for each copy sold. The contract also names a date for publication.

Editing the manuscript. After obtaining the manuscript, the editor prepares it for publication. Editing is the process of putting the author's writing into "publishable" form. The editor looks for parts of the manuscript that call for clarification or reorganization. Spelling, grammar, punctuation, and other elements of style may need to be corrected or altered. Some publishers also have policies or guidelines for the length, organization, and content of their books. The editor may have to verify the accuracy of certain facts in the manuscript. Editing may mean adding or omitting parts, or even rewriting the entire manuscript.

Some publishers divide the editing responsibilities among several people. For example, one editor obtains the manuscript and clarifies its content. Another person may edit it for proper style. Someone else may research all the facts.

Designing and printing. After the manuscript has been edited, it is ready for the designer. The designer is responsible for the overall appearance of the book, including the cover. An attractive book cover can arouse a person's interest in buying the book. In addition, the designer may develop illustrations to accompany the text, including photographs, drawings, charts, and diagrams. For most books, either a designer at the publishing house or a specially hired artist provides the illustrations and cover design. The designer blends the artwork with the edited text in an organized, readable way. In many cases, the designer will work with the author, editor, and other people involved in preparing the book for publication.

After the designer completes his or her work, the book is ready for film output and printing. The edited manuscript is flowed into a page layout. Then the publisher sends the book in electronic form, either on a removable storage device or over a computer network, to a company called a *service bureau.* The service bureau produces images of the book's pages on film and sample copies of each page called *proofs.* The editors, proofreaders, and designers then review the proofs. The author may also check the proofs and revise the material. The bureau produces new film and proofs based on corrections made by the publisher's staff. When the proofs require no further corrections, the film is sent to a printer for use in making printing plates and producing the book.

A book may be *hardbound* or *softbound.* Most hardbound books have covers made of cloth, plastic, or leather over cardboard. Softbound books, also called *paperbacks,* have paper covers. Some books are made first in hardbound and later reprinted as paperbacks. Other books are published only as paperbacks. Normally, paperback books cost less than hardbound books.

Marketing the book. Plans for advertising and distributing begin long before the book comes off the presses. Researchers in the sales department try to estimate the potential readership for the book. Sales representatives collect orders from bookstores and libraries to determine how many copies the printer should produce in time for the official date of publication. Accountants estimate the amount of money that the publisher should spend on advertising and promoting the book.

Publishers use various ways to advertise a book. Publicity specialists may schedule interviews for the author in newspapers and magazines and on television and radio shows. They also send proofs of the book to selected book reviewers in hopes that favorable reviews will reach the public near the date of the book's publication.

As part of their advertising strategy, trade publishers may give advance copies of a book to political figures, television celebrities, or other influential personalities who might praise the book to the public. The publisher may also send the author on tours of bookstores to autograph copies for customers. The publisher watches the progress of sales to determine if and when to order another *printing* (new copies) from the printer.

Careers in publishing

A publishing career appeals to many young people because it involves working in a literary field, sometimes with famous people. The book publishing industry has numerous kinds of jobs. There are positions for writing, editing, illustrating, designing, advertising, selling, research, management, and administration.

A person pursuing a career in book publishing should first choose a general type of work, such as editing or selling. Good writing skills and a background in liberal arts or journalism should help prepare a person for an entry-level editorial position. Most young people begin as editorial assistants and hope to be promoted in time to full editor. A job may require special qualifications based on the material published. For example, many educational publishers require editors to have experience in teaching. Experience working in bookstores may provide a good background for people who wish to go into sales. Interesting careers are also open in promotion and publicity. Some people find employment through agencies that specialize in publishing job placement. Most of these agencies are located in major publishing centers, such as London and New York City.

Many people who wish to publish books start their own businesses. Some begin as *book packagers* who design, research, supply illustrations, and hire writers to create finished books—usually highly illustrated ones—to sell directly to a publisher. The publisher then serves as a distributor for those books. John F. Baker

Related articles in *World Book.* See the *Related articles* in **Journalism** and **Newspaper.** See also:

Bibliography
Book
Bookbinding
Copyright
Desktop publishing
Electronic publishing
Encyclopedia
International standard book number
Internet (Publishing)
Library (Challenges and problems; History)
Magazine
Printing
Proofreading
Type
Writing

Puccini, *poo CHEE nee,* **Giacomo,** *JAH koh moh* (1858-1924), was an Italian opera composer. He ranks as one of the greatest opera composers of all time. Audiences can hear such Puccini operas as *La Bohème* (1896), *Tosca* (1900), *Madama Butterfly* (1904), *The Girl of the Golden West* (1910), and *Turandot* (first performed in 1926, after Puccini's death). Opera companies also present *Il Trittico* (1918), a collection of three one-act operas—*Il Tabarro, Suor Angelica,* and *Gianni Schicchi.*



© Hulton Archive

Giacomo Puccini

Puccini was born on Dec. 23, 1858, in Lucca, the fourth generation of a family of professional musicians. After studying music—unwillingly at first—Puccini became a church organist. Receiving a grant from Queen Margherita, the young Puccini enrolled at the Milan Conservatory in 1880. He submitted his first

opera, the one-act *Le Villi,* in a competition, but did not win. However, the opera was produced successfully in Milan in 1884. His second opera, *Edgar* (1889), was less well received.

With the triumph of *Manon Lescaut* (1893), Puccini began to gain a reputation as the probable successor to the aging Verdi. All 10 of the Puccini operas that followed won international fame for their mastery of theatrical effect, their emotionally charged melodies, and their orchestral brilliance. Puccini was a perfectionist who was concerned with every detail of his operas. His works are tightly written and always delighted his audiences. Of his works composed after 1893, only *La Rondine* (1917), which is almost a musical comedy, has lost popularity. Puccini was working on the last scene of *Turandot* when he died in Brussels, Belgium. The opera was completed by the Italian composer Franco Alfano.

Charles H. Webb

See also **Opera** (The opera repertoire).

Puck, or Robin Goodfellow, a mischievous spirit or elf in English folklore, tormented people, usually in fun. He was also called Hobgoblin, and in 1595, Edmund Spenser, in one of his poems, included *the Pouke* among evil spirits. In *A Midsummer Night's Dream,* William Shakespeare presented him as a good-hearted elf. Enjoying his pranks on human beings, Puck exclaimed, "Lord, what fools these mortals be!" Puck figures prominently in Rudyard Kipling's *Puck of Pook's Hill* and *Rewards and Fairies.* Ellen J. Stekert



Water color (1785) by William Blake; Tate Gallery, London (Bridgeman Art Library)

Puck, *third from left,* was one of the main characters in William Shakespeare's romantic comedy *A Midsummer Night's Dream.* This painting shows Puck dancing for Oberon and Titania, the king and queen of the fairies, *left.*

Pudding stone is a term for a type of *conglomerate stone* consisting of rounded pebbles embedded in a fine-grained *matrix* (cementing material). It is a term used chiefly in the United Kingdom. Finley C. Bishop

Puebla, *PWEHB luh* or *pyoo EHB luh,* is a state in east-central Mexico between Mexico City and the Gulf of Mexico (see **Mexico** [political map]). Puebla has a population of 5,070,346 and an area of 13,090 square miles (33,902 square kilometers). Mexico's three highest mountains, Pico de Orizaba (Citlaltépetl), Popocatépetl, and Ixtacihuatl, stand on Puebla's borders. Puebla farmers grow barley, corn, green peppers, peanuts, potatoes, rice, sugar cane, and wheat. Puebla also produces apples, plums, and other fruits. It is also a textile center. The city of Puebla is the capital. James D. Riley

Puebla, *PWEHB luh* or *pyoo EHB luh* (pop. 1,346,176), officially Puebla de Zaragoza, *day ZAR uh GOH zuh,* one of the largest cities in Mexico, stands 65 miles (105 kilometers) southeast of Mexico City. It is the capital of the state of Puebla. For location, see **Mexico** (political map). Puebla has many beautiful Spanish-style churches and other buildings. The city's chief products include cotton textiles, glass, fine pottery, and beautifully colored tiles. Founded in 1531, Puebla is one of the oldest Spanish settlements in Mexico. Roderic A. Camp

Pueblo, *PWEHB loh* (pop. 102,121; met. area pop. 141,472), is one of the largest cities in Colorado. It serves as the cultural, educational, and industrial center for the southeastern part of the state. Pueblo lies at the junction of the Arkansas River and Fountain Creek. For the city's location, see **Colorado** (political map).

Pueblo's industries include the manufacture of air conditioners, airliner brake pads, bricks and tiles, and steel. Rocky Mountain Steel Mills (formerly CF&I Steel Corporation) is the city's oldest and largest employer. The steel plant began operations in 1881. Pueblo is the home of the University of Southern Colorado and the Sangre de Cristo Arts and Conference Center. Since 1872, the city has hosted the annual Colorado State Fair, held in August.

Arapaho, Cheyenne, and Ute Indians lived in eastern Colorado when Europeans first came to the area. In 1840, trappers built Fort Pueblo on the site of what is now Pueblo. The Ute killed the fort's inhabitants in 1854. Gold prospectors settled on the site in 1858 and named their community Fountain City. It was incorporated as the city of Pueblo in 1860.

In the 1970's, Pueblo began a downtown modernization program. The Pueblo Mall opened in 1976. The Pueblo Convention Center opened in 1997. It includes meeting and exhibit space, and a large ballroom. An eight-story hotel, at the convention center, opened in 1998. Pueblo has a council-manager government. It is the county seat of Pueblo County. Leonard W. Gregory

For monthly weather, see **Colorado** (Climate).

Pueblo Indians, *PWEHB loh,* are a people who live in villages in New Mexico and Arizona. The Pueblo belong to many communities, each of which speaks one of six languages. These Indians were named in the 1500's by Spanish explorers. The Spaniards found them living in villages that resembled Spanish towns, and the word *pueblo* means *town* in Spanish. The Spaniards used the word to refer to both the people and their villages.

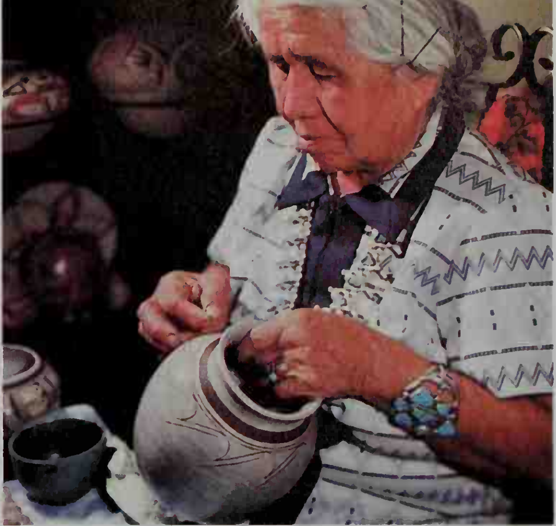
Most of the 53,000 Pueblo live in 19 villages in New Mexico. The majority live along the Rio Grande, in areas between Taos and Albuquerque. Others live in deserts or high plateau areas called *mesas* in Laguna and Acoma in west-central New Mexico. This article discusses the Indians who live in the 19 villages. Other Pueblo include the Zuni of western New Mexico and the Hopi of northeastern Arizona (see **Hopi Indians; Zuni Indians**).

Each Pueblo village has its own government and organization, but the Pueblo people remain linked to one another because of similar customs. The Pueblo have strong ties to their traditions and homeland. They have lived in the same location longer than any other people of the United States or Canada.



Jerry D. Jacka

A Pueblo village of today looks much like the Pueblo towns of centuries ago. The Pueblo have traditionally lived in stone or adobe structures that resemble apartment buildings.



Pottery Treasures, © 1976 by Graphic Arts Center Publishing Co. (Jerry D. Jacka)

Colorful pottery is created by people in all Pueblo villages. The pottery of each village has its own special designs. This Pueblo woman is painting a handmade jar.

Early life. The Pueblo are descendants of a people known as the *Anasazi,* a name given them by the Navajo Indians. The Anasazi began to build homes of many stories about A.D. 700. Between A.D. 1000 and 1300, Pueblo culture developed greatly in northern Arizona, northern New Mexico, southern Colorado, and southern Utah. By 1300, many Pueblo had moved south to the fertile valleys of the Rio Grande and its branches.

Some Pueblo Indians built villages in the valleys, and others lived in desert and mountain areas. Desert surrounded many of the valleys, and the people set up irrigation systems so they could grow crops. Pueblo women gathered berries and other foods, and the men hunted game.

Pueblo villages consisted of stone or adobe structures that resembled apartment buildings. These homes had as many as four stories, and the Indians used ladders to reach the upper levels. Some families of grandparents, parents, children, aunts, and uncles lived in two or more connected dwellings.

The villages were governed by religious leaders. The Pueblo held many religious ceremonials to promote harmony and order in the universe. They believed that if harmony and order in the universe were maintained, the spirits would ensure abundant game and provide sufficient rain for their crops. Pueblo men performed *kachina dances,* in which they represented spirits of the earth, sky, and water. The dancers wore masks that symbolized the spirits. Most pueblos had underground chambers called *kivas* that were used for ceremonies and meetings.

The Pueblo designed excellent pottery. They also wove beautiful baskets and cotton for their clothing.

Contact with other peoples. In 1598, the Spaniards established a settlement near a Pueblo village. They forced the Pueblo to work for them and to give them some of their crops. The Spaniards also forced the Indians to follow Roman Catholic ways. The Pueblo pretended to accept Catholicism, but they secretly continued their own religious practices.

In 1680, the Pueblo leader Popé led his people in a revolt that ended Spanish rule. The Indians remained free until 1692, when the Spaniards again gained control. In return for yielding control, the Pueblo demanded an end to forced labor and to interference in their internal affairs, particularly their religion.

From 1821 to 1846, Mexico ruled the Pueblo lands. The United States gained the territory from Mexico as a result of the Mexican War (1846-1848). In the Treaty of Guadalupe Hidalgo of 1848, the United States agreed to uphold the Pueblo's title to their lands, which had been recognized by both the Spanish and the Mexican governments.

Through the years, the Pueblo have sought greater economic and political rights. In 1970, for example, the pueblo of Taos won title to Blue Lake, a sacred lake to the Indians of Taos. The government had made it part of a national forest.

The Pueblo today follow many of the traditions that their ancestors established centuries ago. Most Pueblo have accepted modern ways only if such changes seem necessary or practical.

Most Pueblo practice their ancient religion, though some observe certain Catholic customs. Religious officials and nonreligious officials appointed by them govern 13 of the New Mexico villages. The people of the other 5 villages elect their officials.

The majority of Pueblo live in homes that have only one story. Most of them work in nearby cities and towns, and many have professional careers. The Pueblo also make baskets, jewelry, pottery, and weavings and sell almost all their crafts. Alfonso Ortiz

Related articles in World Book include:

Anasazi
Doll (Doll festivals and customs)
Hopi Indians
Indian, American (Indians of the Southwest; pictures)
Indian wars (The Pueblo revolt)
Popé
Zuni Indians

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Sando, Joe S. *Pueblo Nations.* Clear Light Pubs., 1992.

Yue, Charlotte and David. *The Pueblo.* 1986. Reprint. Houghton, 1990.



Bob Glander, Shostal

San Juan is Puerto Rico's capital and largest city. Modern hotels and condominiums line the city's shore. Puerto Rico's warm climate, sandy beaches, and scenic and historic sites attract many tourists. Puerto Rico is a commonwealth of the United States.

Puerto Rico

Puerto Rico, *PWAIR tuh REE koh* or *PAWR tuh REE koh,* is a beautiful, fertile island about 1,000 miles (1,600 kilometers) southeast of Florida. It forms part of the boundary between the Atlantic Ocean and the Caribbean Sea. The pleasant climate, sandy beaches, and resort hotels attract a large number of tourists from the United States mainland. Puerto Rico is a possession of the United States, with commonwealth status. Its official name is Commonwealth of Puerto Rico.

Puerto Ricans are U.S. citizens, and can move to the mainland without immigration restrictions. But when living on the island, they cannot vote in presidential elections and do not pay federal income taxes. The commonwealth receives assistance and protection from the U.S. government. But the Puerto Rican government has authority in many local matters.

Puerto Rico is the only part of what is now the United States where Christopher Columbus landed. Columbus reached the island in 1493 and claimed it for Spain. He named the island San Juan Bautista (St. John the Baptist). Spain surrendered the island to the United States in 1898 at the end of the Spanish-American War.

The name *Puerto Rico* means *rich port* in Spanish. In

The contributor of this article is Fernando Bayrón-Toro, Professor of Political Sciences at the University of Puerto Rico, Mayagüez.

Facts in brief

Capital: San Juan.
Government: *Congress*—Resident commissioner, who votes only in committees. *Commonwealth legislature*—senators, 28; representatives, 54. *Local government*—78 municipalities.
Area: 3,515 mi² (9,103 km²), including Culebra, Mona, and Vieques islands and 56 mi² (145 km²) of inland water. *Greatest distances*—east-west, 111 mi (179 km); north-south, 39 mi (63 km). *Coastline*—311 mi (501 km).
Elevation: *Highest*—Cerro de Punta, 4,389 ft (1,338 m) above sea level. *Lowest*—sea level along the coast.
Population: *2000 census*—3,808,610; density, 1,084 per mi² (418 per km²); distribution, 67 percent urban, 33 percent rural.
Chief products: *Agriculture*—milk, poultry and eggs, beef cattle, coffee. *Fishing industry*—lobsters. *Manufacturing*—pharmaceuticals, food products, electrical equipment, machinery, scientific instruments, clothing.
Became a commonwealth: July 25, 1952.
Commonwealth abbreviations: P.R. (traditional); PR (postal).
Commonwealth motto: *Joannes est nomen ejus* (John Is His Name).
Commonwealth anthem: "La Borinqueña." Music by Felix Astol y Artés.



Odyssey Productions

The Cordillera Central, a mountain range, stretches across south-central Puerto Rico. The island's highest peak, Cerro de Punta, rises 4,389 feet (1,338 meters) in the range. This mountain region also has fertile valleys, where farmers grow coffee and many kinds of citrus fruits.

early colonial days, it was the name for San Juan, Puerto Rico's capital and largest city. The name gradually came to be used for the entire island.

Puerto Rico's Spanish heritage is reflected in the language and customs of its people. Spanish is the main language and one of the two official languages of Puerto Rico. Many Puerto Ricans also speak English, the other official language. The people celebrate religious holidays with colorful festivals. Churches and forts from Spanish colonial days still stand on the island.

Puerto Rico also reflects its ties with the United States. The island's large cities have freeways, housing projects, and shopping centers like those in many cities on the U.S. mainland.

Government

Puerto Rico is a commonwealth of the United States. The U.S. Congress is responsible for governing Puerto Rico, but the island exercises self-government in all local affairs. Most federal laws apply to Puerto Rico as though it were a state. A resident commissioner, elected to a four-year term, represents Puerto Rico in Congress. The resident commissioner may vote in committees of the House of Representatives, but may not vote on final legislation in the House.

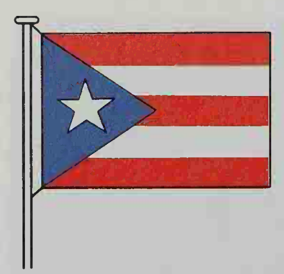
Commonwealth government operates under its own Constitution, adopted in 1952. The governor is the chief executive officer and appoints other top executive officials. The governor is elected to a four-year term and may serve an unlimited number of terms.

The legislature of Puerto Rico consists of a senate and a house of representatives. Members of both houses



WORLD BOOK map

Puerto Rico lies between the Atlantic Ocean and the Caribbean Sea. It is southeast of the mainland of the United States.





Symbols of Puerto Rico. The flag was designed about 1895 and was officially adopted in 1952. On the seal, the lamb symbolizes peace and brotherhood. The letters *F* and *I* stand for King Ferdinand and Queen Isabella of Spain.

serve four-year terms. Puerto Rico has 8 senatorial districts and 40 representative districts. Voters in each senatorial district elect 2 senators, and voters in each representative district elect 1 representative. Voters also elect 11 senators and 11 representatives *at-large*—that is, from the entire commonwealth, rather than from districts. If one political party controls more than two-thirds of the seats of either house, the minority parties get extra senators at-large or representatives at-large.

The legislature meets in regular session from January through May and during September and October. The governor may call special sessions at any time.

Courts. The Supreme Court is the highest court in Puerto Rico. It has seven justices appointed by the governor. The justices may serve until they reach the retirement age of 70. The Circuit Court of Appeals consists of 33 judges, each appointed by the governor to 16-year terms. Puerto Rico's 210 superior court judges are appointed to 12-year terms. The 105 municipal judges are appointed to 8-year terms. Cases involving federal law are heard in the U.S. District Court for Puerto Rico, which has seven judges appointed by the U.S. president.

Local government. Puerto Rico's basic unit of local government is the *municipio* (municipality). The commonwealth is divided into 78 municipalities. The voters in each municipality elect a mayor and an assembly. The mayor appoints a secretary-auditor and a treasurer.



© Ray Ellis, Photo Researchers

Puerto Rico's capitol, in San Juan, was first used in 1929. San Juan has been the capital since 1521. The first capital, established in 1508, was Caparra, across the bay from San Juan.

Politics. Political parties that get at least 5 percent of the vote cast in elections receive financial aid from a government fund. Puerto Rico's two leading parties are the New Progressive Party, which wants Puerto Rico to become a U.S. state; and the Popular Democratic Party, which favors continuing the island's commonwealth status. A third party is the Independence Party, which favors independence for the island.

People

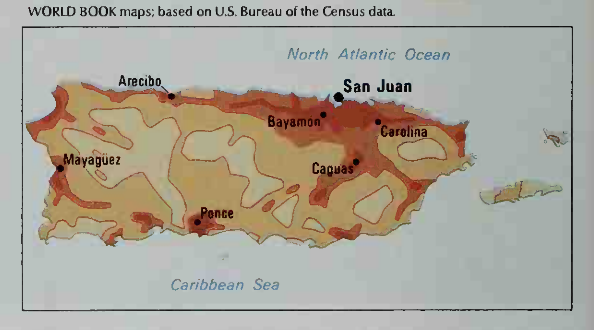
Puerto Rico is a crowded island. It has a population density of about 1,000 persons per square mile (400 per

Population density

Puerto Rico is a densely populated island. About two-thirds of the island's people live in urban areas. The San Juan area is Puerto Rico's most heavily populated region.

Persons per sq. mi.	Persons per km^2
More than 1,000	More than 400
750 to 1,000	300 to 400
500 to 750	200 to 300
Less than 500	Less than 200

WORLD BOOK maps; based on U.S. Bureau of the Census data.





square kilometer), which is greater than the density of any U.S. state. The 2000 United States census reported that Puerto Rico had 3,808,610 people. The island's population had increased 8 percent over the 1990 figure, 3,522,037.

More than four-fifths of all Puerto Ricans live within the metropolitan areas of Aquadilla, Arecibo, Caguas, Mayagüez, Ponce, and San Juan (see **Metropolitan area**). For the populations of these metropolitan areas, see the *Index* to the political map of Puerto Rico.

San Juan, Puerto Rico's capital and largest city, is a seaport on the north coast. The San Juan metropolitan area includes Bayamón and Carolina, the next largest cities. Ponce, the fourth largest city, is a commercial and cultural center on the south coast. Other major cities of Puerto Rico include Caguas, the largest inland city; Guaynabo, near San Juan; and Mayagüez, on the west coast.

The first inhabitants of Puerto Rico were the Arawak Indians. Most of them were killed or died of disease after the Spanish settlers came. No full-blooded Indians are now known to live in Puerto Rico. But some Puerto Ricans are descended from Indians who intermarried with Spanish settlers. Beginning in 1510, blacks were

Puerto Rico map index

Population

Population		Year
3,808,610	Census	2000
3,522,037	"	1990
3,196,520	"	1980
2,712,033	"	1970
2,349,544	"	1960
2,210,703	"	1950
1,869,255	"	1940
1,543,913	"	1930
1,299,809	"	1920
1,118,012	"	1910

Metropolitan areas

Name	Population
Aguadilla	146,424
Arecibo	174,300
Caguas	308,365
Mayagüez	253,347
Ponce	361,094
San Juan	1,967,627

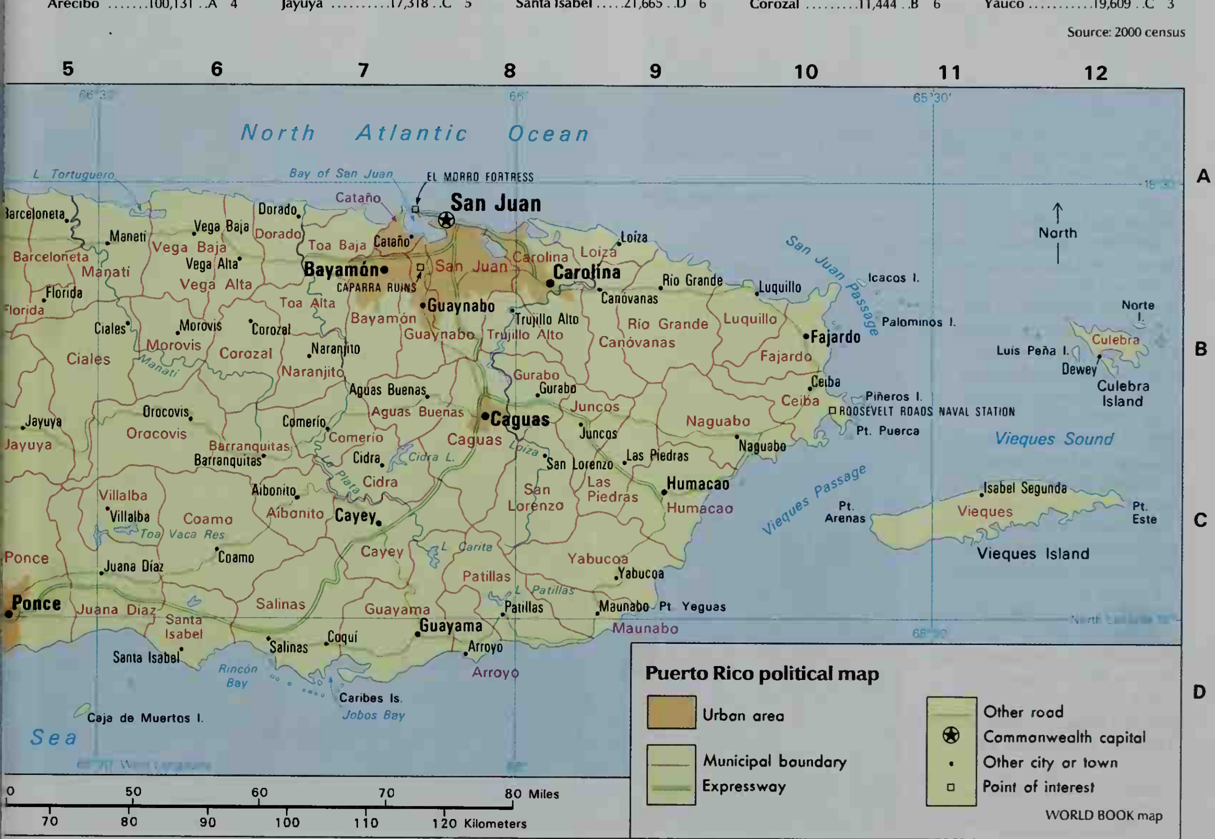
Municipalities

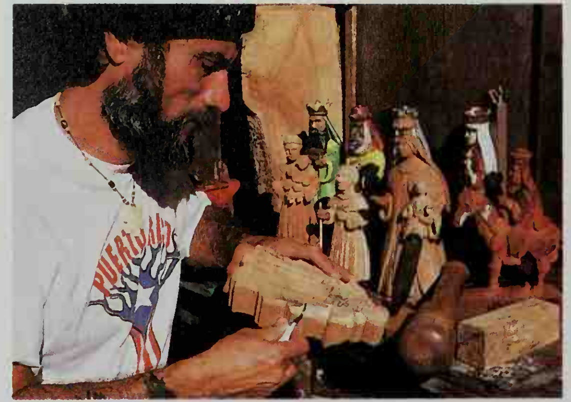
Name	Population	Row	Column
Adjuntas	19,143	C	4
Aguada	42,042	B	1
Aguadilla	64,685	A	1
Aguas Buenas	29,032	B	7
Aibonito	26,493	C	6
Añasco	28,348	B	2
Arecibo	100,131	A	4
Arroyo	19,117	D	8
Barceloneta	22,322	A	5
Barranquitas	28,909	C	6
Bayamón	224,044	B	7
Cabo Rojo	46,911	C	1
Caguas	140,502	C	8
Camuy	35,244	A	3
Canóvanas	43,335	B	9
Carolina	186,076	A	8
Cataño	30,071	A	7
Cayey	47,370	C	7
Ceiba	18,004	B	10
Ciales	19,811	B	5
Cidra	42,753	C	7
Coamo	37,597	C	6
Comerio	20,002	C	7
Corozal	36,867	B	6
Culebra	1,868	B	12
Dorado	34,017	A	6
Fajardo	40,712	B	10
Florida	12,367	B	5
Guánica	21,888	D	3
Guayama	44,301	D	7
Guayanilla	23,072	C	4
Guaynabo	100,053	B	7
Gurabo	36,743	B	8
Hatillo	38,925	A	3
Hormigueros	16,614	C	1
Humacao	59,035	C	9
Isabela	44,444	A	2
Jayuya	17,318	C	5
Juana Diaz	50,531	D	5
Juncos	36,452	B	9
Lajas	26,261	C	2
Lares	34,415	B	3
Las Marias	11,061	B	3
Las Piedras	34.485	C	9
Loíza	32,537	A	9
Luquillo	19,817	B	10
Manatí	45,409	B	5
Maricao	6,449	C	3
Maunabo	12,741	D	9
Mayagüez	98,434	C	2
Moca	39,697	B	2
Morovis	29,965	B	4
Naguabo	23,753	B	9
Naranjito	29,709	B	7
Orocovis	23,844	C	6
Patillas	20,152	C	8
Peñuelas	26,719	C	4
Ponce	186,475	C	5
Quebradillas	25,450	A	3
Rincón	14,767	B	1
Río Grande	52,362	B	9
Sabana Grande	25,935	C	3
Salinas	31,113	D	6
San Germán	37,105	C	2
San Juan	434,374	A	8
San Lorenzo	40,997	C	8
San Sebastián	44,204	B	3
Santa Isabel	21,665	D	6
Toa Alta	63,929	B	7
Toa Baja	94,085	A	7
Trujillo Alto	75,728	B	8
Utuado	35,336	B	4
Vega Alta	37,910	B	6
Vega Baja	61,929	A	6
Vieques	9,106	C	11
Villalba	27,913	C	5
Yabucoa	39,246	C	9
Yauco	46,384	C	3

Cities, towns, and villages

Name	Population	Row	Column
Adjuntas	4,980	C	4
Aguadilla	16,776	A	1
Aibonito	9,269	C	6
Arecibo	49,318	A	4
Arroyo	7,244	D	8
Bayamón	203,499	B	7
Cabo Rojo	10,610	C	1
Caguas	88,680	B	8
Canóvanas	8,069	B	9
Carolina	168,164	B	8
Cataño	30,071	A	7
Cayey	19,940	C	7
Cidra	4,881	C	7
Coamo	12,356	C	6
Comerio	4,478	C	7
Corozal	11,444	B	6
Dorado	12,747	A	6
Fajardo	33,286	B	10
Guánica	9,247	D	3
Guayama	21,624	D	7
Guayanilla	5,110	D	3
Guaynabo	78,806	B	7
Gurabo	9,046	B	8
Hormigueros	12,444	C	2
Humacao	20,682	C	9
Isabela	12,818	A	2
Juana Diaz	9,505	C	5
Juncos	8,978	C	9
Manatí	16,173	A	5
Mayagüez	78,647	C	1
Ponce	155,038	D	5
Río Grande	13,467	B	9
Sabana Grande	8,784	C	3
Salinas	6, 141	D	6
San Germán	12,033	C	2
San Juan	421,958	A	8
San Lorenzo	8,947	C	8
San Sebastián	11,598	B	3
Santa Isabel	6,993	D	6
Trujillo Alto	50,841	B	8
Utuado	9,887	B	4
Vega Alta	11,755	B	6
Vega Baja	28,811	A	6
Yabucoa	6,636	C	9
Yauco	19,609	C	3

Source: 2000 census





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Traditional wood figures, called *santos,* are carved by craftworkers known as *santeros.* Most santos represent a saint or a religious scene. This santero has made several Nativity figures.



David R. Frazier Photolibrary

A game of dominoes occupies the leisure time of these men. Most Puerto Ricans have Spanish ancestors. Others include people of black African, Portuguese, Italian, and French descent.

brought from Africa to work on the plantations and in the small gold mines. Today, their descendants live chiefly in the lowlands near the coast.

By far the largest part of the population is of Spanish descent. There are also Portuguese, Italians, and French. About 85 percent of the people are Roman Catholics, and most of the rest are Protestants.

Education

About 90 percent of Puerto Rico's people can read and write. The island has a public school system similar to those in the states. Puerto Rico's public school system has about 39,000 teachers and 765,000 students. About 150,000 students attend private schools. Spanish is the main language used in schools, but students are also taught English.

Visitor's guide

Beaches lined with palm trees surround Puerto Rico's interior of rugged mountain ranges and rolling hills. The island offers a variety of water sports. Many visitors enjoy the historic buildings and colorful shops in the older part of San Juan, called Old San Juan, and in the island's cultural center, Ponce. United States citizens do not need passports to travel to Puerto Rico.

Universities and colleges

This table lists the universities and colleges in Puerto Rico that grant bachelor's or advanced degrees and are accredited by the Middle States Association of Colleges and Schools.

Name	Mailing address
Advanced Studies on Puerto Rico and the Caribbean, Center for	San Juan
American University of Puerto Rico	Bayamón
Antillian Adventist University	Mayagüez
Bayamón Central University	Bayamón
Caribbean University	Bayamón
Carlos Abizu University	San Juan
Conservatory of Music of Puerto Rico	San Juan
East, University College of the	Carolina
Evangelical Seminary of Puerto Rico	San Juan
Inter American University of Puerto Rico	*
Metropolitan University	Río Piedras
Polytechnic University of Puerto Rico	San Juan
Pontifical Catholic University of Puerto Rico	†
Puerto Rico, University of	‡
Puerto Rico School of the Plastic Arts	San Juan
Sacred Heart, University of the	Santurce
Turabo, University of	Gurabo

*Campuses at Aguadilla, Arecibo, Barranquitas, Bayamón, Fajardo, Guayama, Hato Rey, Mercedita, San Germán, and San Juan.
†Campuses at Arecibo, Guayama, Mayagüez, and Ponce.
‡Campuses at Aguadilla, Arecibo, Bayamón, Carolina, Cayey, Humacao, Mayagüez, Ponce, Río Piedras, San Juan, and Utuado.



David R. Frazier Photolibrary

The University of Puerto Rico, founded in 1903, has a beautifully ornamented administration building, *shown here,* on the campus at Rio Piedras. The school has several other campuses.

Places to visit

Following are brief descriptions of some of Puerto Rico's many interesting places to visit:

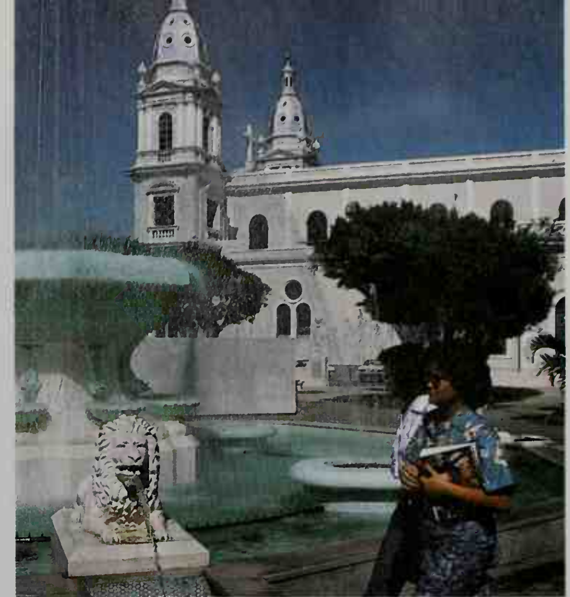
El Morro Fortress was built by the Spaniards between 1539 and 1787 to guard the Bay of San Juan.

El Yunque, "the anvil," is a mountain with a rain forest on its slopes. The El Yunque rain forest is part of the Caribbean National Forest and is the only rain forest in the U.S. Forest Service. The forest has about 240 species of trees and flowers.

Hacienda Buena Vista, in Ponce, is a restored coffee and grain mill from the 1800's. It includes rare turbine machinery and period furnishings.

Ponce Art Museum has the Caribbean's most extensive art collection. Its collection ranges from works by European old masters to those of modern artists.

Rio Camuy Cave Park, near Arecibo, has spectacular limestone caves carved thousands of years ago by one of the world's largest underground rivers.



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Fountain in the main plaza of Ponce



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A narrow, shop-lined street in Old San Juan



Southern Stock

Resort hotels and beaches in San Juan

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El Morro Fortress stands on a bluff overlooking the Bay of San Juan. Spaniards built the fort between 1539 and 1787.

Annual events

One of Puerto Rico's leading events is the Casals Festival, held in San Juan in mid-June. International musicians take part in orchestra and chamber music performances to honor the famed Spanish cellist Pablo Casals, whose mother was born in Puerto Rico.

Puerto Ricans have many interesting holidays and customs. Three Kings' Day, January 6, marks the end of the Christmas season. Puerto Rican children receive gifts on that day, as well as at Christmas. Each town has a patron saint, and each celebrates its saint's day with a festival. Other annual events in Puerto Rico include:

January-March: Birthday of Puerto Rican educator and essayist Eugenio Maria de Hostos (January 11); Carnival in Ponce (February); Coffee Harvest Festival in Maricao (February); Orange Festival in Las Marías (February); Dulce Sueño Paso Fino Horse Show in Guayama (late February to early March); Heineken Regatta, first leg of the Caribbean Ocean Racing Triangle (March); Emancipation Day, marking abolition of slavery in 1873 (March 22).

April -June: Birthday of Jose de Diego, a Puerto Rican patriot (April 16); Heineken Jazz Festival in San Juan (May); Bomba y Plena Festival, an Afro-Caribbean music and dance festival in Ponce (June); Aibonito Flower Festival (June); Eve of San Juan Bautista Day (June 23).

July-September: Barranquitas Artisans Fair (mid-July); Commonwealth Day (July 25); Loiza Festival, a folk and religious festival honoring St. James the apostle (late July); International Billfish Tournament in San Juan (August-September); Inter-American Festival of the Arts in San Juan (September-October).

October-December: Columbus Day (October 12); Jayuya Indian Festival (November); Discovery Day, honoring Columbus's 1493 sighting of Puerto Rico (November 19); Hatillo Festival of the Masks (late December).



© Claudia Parks, The Stock Market

Dancers in traditional costumes perform folk dances in Old San Juan. Puerto Ricans celebrate many holidays with colorful festivals that feature traditional music and dancing.

The land

Puerto Rico is one of the largest islands that lie between Florida and South America. It covers 3,515 square miles (9,103 square kilometers). Puerto Rico includes many smaller islands. The largest, in order of size, are Vieques, Mona, and Culebra.

Land regions. Puerto Rico has four main land regions. They are (1) the Coastal Lowlands, (2) the Coastal Valleys, (3) the Foothills, and (4) the Central Mountains.

The Coastal Lowlands border the coast on the north and the south. The northern lowlands are about 8 to 12 miles (13 to 19 kilometers) wide. Their climate is generally humid.

The southern lowlands cover a narrower area, and have a much drier climate. Most of Puerto Rico's industry and its largest cities, San Juan, Bayamón, Ponce, and Carolina, are in the lowlands.

The Coastal Valleys extend inland from the coast on the east and the west. Most of the land in these valleys is used for sugar cane. Coconuts and other fruits also grow in these areas.

The Foothills rise in two long east-west chains, just inland from the northern and southern coastal lowlands. Much of the area has jagged peaks and round basins. The basins formed when water wore away the limestone under the hills, and the ground sank.

The Central Mountains run east and west across the south-central part of the island. The main range is the Cordillera Central. The highest peak in Puerto Rico,

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The Coastal Lowlands border Puerto Rico's coast on the north and the south. Farmland in the northern lowlands, near Arecibo, is shown here. Farmland covers more than half of Puerto Rico's total land area.



Chip and Rosa Maria Peterson

The Coastal Valleys extend inland from the east and west coasts. The scene at the left is in the east. Much sugar cane is grown in the Coastal Valleys.

Cerro de Punta, rises 4,389 feet (1,338 meters) in the Cordillera Central. This mountain region also contains many fertile valleys, in which farmers raise crops. Coffee is the main crop of the western part of the region. Citrus fruits are also grown in the mountain valleys.

Coastline. Puerto Rico's general coastline measures 311 miles (501 kilometers). The tidal shoreline, which includes small bays and inlets, is about 700 miles (1,127 kilometers) long. The island has many beaches and harbors.

Puerto Rico terrain map

WORLD BOOK map

Land region boundary
+ Elevation above sea level
⊛ Commonwealth capital
• City

1 2 3 4 5 6 7

A B C

67°00' West Longitude
66°30'

North Atlantic Ocean
Pt. Borinquen
Pt. Sardina
Pt. Las Tunas
Aguadilla Bay
COASTAL VALLEYS
Arecibo
Bay of San Juan
L. Tortuguero
San Juan
Pt. Maldonado
COASTAL LOWLANDS
Guajataca Lake
Arecibo
Culebrinas
Pt. Higuero
FOOTHILLS
L. San José
Loíza
Pt. Picúa
San Juan Passage
Cape San Juan
Icacos I.
Palominos I.
La Plata
Bayamón
Lake Loíza
Sierra de Luquillo
El Yunque 3,494 ft. (1,065 m)
El Toro 3,524 ft. (1,074 m)
Piñeros I.
Culebra Island
Añasco
Lake Caonillas
Manatí
Mayagüez
Mayagüez Bay
Montañas de Uroyan
Blanco
Cerro de Punta 4,389 ft. (1,338 m)
CENTRAL MOUNTAINS
Caguas
Pt. Puerca
Vieques Sound
Cidra Lake
COASTAL VALLEYS
Monte Guilarte 3,953 ft. (1,205 m)
Cordillera Central
Toa Vaca Res.
Cerro la Santa 2,963 ft. (903 m)
Vieques Passage
Vieques Island
Yauco
FOOTHILLS
Sierra de Cayey
Boquerón Bay
L. Cartagena
Ponce
COASTAL LOWLANDS
Pt. Yeguas
Cape Rojo
Pt. Brea
Guayanilla Bay
Rincon Bay
Pt. Figuras
North
Phosphorescent Bay
Caribes Is.
Caja de Muertos I.
Caribbean Sea

Mona Island lies about 40 miles (64 kilometers) west of Puerto Rico.

0 20 40 60 80 100 120 Miles
0 20 40 60 80 100 120 140 160 180 Kilometers

Physical features

Feature		
Aguadilla Bay	A	1
Arecibo River	B	1
Bay of San Juan	A	4
Bayamón River	B	4
Boquerón Bay	C	1
Caja de Muertos Island	C	3
Cape Rojo	C	1
Cape San Juan	A	6
Caribes Island	C	4
Cerro de Punta (mountain)	B	3
Cerro la Santa (mountain)	B	5
Cidra Lake	B	5
Cordillera Central (mountains)	B	3
Culebra Island	B	7
Culebrinas River	A	1
El Toro (mountain)	B	6
El Yunque (mountain)	B	6
Guajataca Lake	A	2
Guayanilla Bay	C	2
Icacos Island	A	6
Lake Caonillas	B	3
Lake Cartagena	C	1
Lake Loíza	B	5
Lake San José	A	5
Lake Tortuguero	A	3
La Plata River	B	4
Mayagüez Bay	B	1
Montañas de Uroyan (mountains)	B	1
Monte Guilarte (mountain)	B	2
Palominos Island	B	6
Phosphorescent Bay	C	1
Piñeros Island	B	6
Point Las Tunas	A	2
Point Maldonado	A	5
Point Puerca	B	6
Rincón Bay	C	4
San Juan Passage	A	6
Sierra de Cayey (mountains)	C	5
Sierra de Luquillo (mountains)	B	5
Toa Vaca Reservoir	B	3
Vieques Island	B	7

Rivers. Puerto Rico's longest rivers, such as the Arecibo, flow northward from the mountains into the Atlantic Ocean. None of the rivers can be used by large boats. But they are important sources of water for hydroelectric power, industries, and irrigation.

Plant and animal life. Much of the tropical forest that formerly covered Puerto Rico is gone. Many of the remaining trees are valued for their beauty. These include the *flamboyan* (poinciana), with flaming red blossoms; the African tulip; and the huge *ceiba* (kapok). Some trees bear delicious fruits and nuts that are little known elsewhere in the United States. Among these are breadfruit, guanábanas, papayas, sea grapes, and star apples.

Many beautiful flowers grow on the island. They include orchids and poinsettias.

Puerto Rico has few wild animals. Bats and mongooses are found on the island. Puerto Rico has few snakes of any kind and no poisonous ones. However, it has iguanas and other lizards. It also has many kinds of birds. The coquí (a small frog) sounds a clear, musical note during the evening hours. The island's many insects include the cucubano, a large tropical relative of the common firefly. Some insects, such as mole crickets and termites, may damage buildings and crops. The Puerto Rico Paso Fino Horse, famous for its delicate way of walking, is bred on the island.

Fishes in the ocean around Puerto Rico include barracuda, herring, marlin, mullet, pompano, sharks, snappers, Spanish mackerel, and tuna. Lobsters and oysters are also caught in Puerto Rican waters.



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A tropical rain forest on El Yunque mountain, *above,* may receive more than 200 inches (510 centimeters) of rain a year. The area makes up part of the Caribbean National Forest.

Climate

Puerto Rico's pleasant climate makes the island a popular vacation spot. The climate also provides good conditions for growing crops. Temperatures average about 73° F. (23° C) in January and 80° F. (27° C) in July. Frost and snow never occur, and even hail is rare. Sea breezes make the climate much more comfortable in summer than it is in the central United States.

In many parts of the island, some rain falls nearly every day. The rainfall is usually heavy, but it lasts only a short time. The drier sections of the southern coast average 37 inches (94 centimeters) of rain a year. Rainfall in the north averages 70 inches (180 centimeters) a year. A rain forest on El Yunque, a mountain, sometimes gets over 200 inches (510 centimeters) a year.

People in Puerto Rico must be alert for hurricanes from June through November. But severe hurricanes occur only once every 10 years, on the average. These storms are predicted hours or even days in advance by the National Weather Service. The storm warnings are announced by newspapers, radio, and television so that people have time to take shelter in strong buildings.

The highest temperature ever recorded in Puerto

Average yearly precipitation

This map shows the average amount of rain and other moisture that Puerto Rico receives in a year. In many parts of the island, some rain falls nearly every day.

WORLD BOOK map

Inches	Centimeters
More than 100	More than 250
80 to 100	200 to 250
60 to 80	150 to 200
40 to 60	100 to 150
Less than 40	Less than 100

North Atlantic Ocean
Arecibo
San Juan
Mayagüez
Caguas
Ponce
Caribbean Sea

Average monthly weather

San Juan

	Temperatures F° High	F° Low	C° High	C° Low	Days of rain or snow
Jan.	80	70	27	21	20
Feb.	80	70	27	21	14
Mar.	81	71	27	22	14
Apr.	82	72	28	22	14
May	84	74	29	23	16
June	84	75	29	24	17
July	84	76	29	24	19
Aug.	85	76	29	24	20
Sept.	86	75	30	24	18
Oct.	85	75	29	24	18
Nov.	83	74	28	23	19
Dec.	81	72	27	22	20

Rico, 103 °F (39 °C), occurred at San Lorenzo on Aug. 22, 1906. The lowest temperature, 40 °F (4 °C), was recorded at Aibonito on March 9, 1911.

Economy

Manufacturing is the single most valuable industry in Puerto Rico. It provides a larger portion of the *gross domestic product* than any other economic activity. Gross domestic product is the total value of all goods and services produced within a region in a year. The service industries, taken together, supply more than half of the gross domestic product of Puerto Rico.

Millions of tourists visit Puerto Rico every year. Most of them come from the United States mainland. Tourist activities benefit many parts of Puerto Rico's economy, especially such services as the operation of hotels and restaurants.

Natural resources. One of Puerto Rico's most important natural resources is its climate. The year-round balmy weather not only attracts many tourists but also helps make Puerto Rico a desirable location for industries. The warm, moist climate also allows Puerto Ricans to grow tropical crops.

Soil is an important resource in Puerto Rico. The island has more than 400 types of soil. Soil erosion is a serious problem on the island, but it is being reduced by soil conservation methods such as contour planting.

Minerals. Clays, limestone, salt, sand and gravel, and stone account for almost all of Puerto Rico's mine production. Spanish settlers washed gold out of Puerto Rican streams, but the gold supply was soon used up. Small deposits of cobalt and nickel and two large copper deposits have been found on the island. Salt is made from seawater.

Service industries, taken together, make up the largest portion of the gross domestic product of Puerto Rico. Most of the service industries are concentrated in the metropolitan areas.

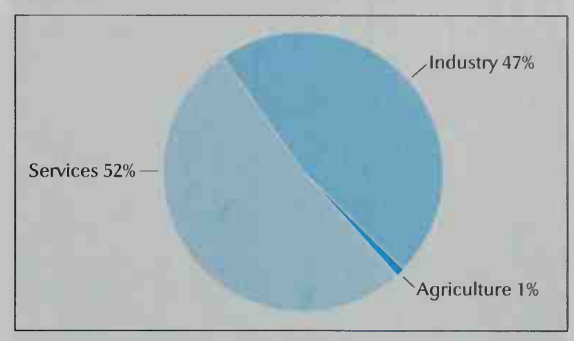
Both (1) wholesale and retail trade and (2) finance, insurance, and real estate lead the service industries of Puerto Rico in terms of contributions to the gross do-



© David R. Frazier

Pharmaceutical manufacturing is an important economic activity in Puerto Rico. These workers are packaging medicinal drugs at a pharmaceutical factory near San Juan.

Puerto Rico's gross domestic product



The gross domestic product (GDP) is the total value of goods and services produced in a region in a year, minus income sent or received from abroad. The GDP can be used to compare the economic performances of countries and regions. Puerto Rico's GDP was $59,900,000,000 in 1999.

Production and workers by economic activities

Economic activities	Percent of GDP produced	Employed workers: Number of people	Employed workers: Percent of total
Manufacturing	44	159,000	14
Wholesale & retail trade	13	229,000	20
Finance, insurance, & real estate	13	43,000	4
Community, business, & personal services	10	306,000	27
Government	9	246,000	21
Transportation, communication, & utilities	7	59,000	5
Construction & mining	3	78,000	7
Agriculture	1	27,000	2
Total	100	1,147,000	100

Figures are for 1999.
Sources: GDP data, Puerto Rico Planning Board; employment data, *World Book* estimates based on data from Puerto Rico Department of Labor.

mestic product. The wholesale trade of clothing, medicine, and sugar is especially important. San Juan, Bayamón, and Ponce are the leading centers of wholesale trade. Puerto Rico's retail trade is aided by tourist spending at shops and restaurants.

Rapidly growing cities make real estate especially important in Puerto Rico. San Juan is the chief financial center, home to hundreds of banks and other financial organizations.

Taken together, (1) community, business, and personal services and (2) government services employ nearly half of all Puerto Ricans. Community, business, and personal services include private health care and tourism. Government services include military activities and the operation of public schools and hospitals.

Information on transportation, communication, and utilities appears later in this section.

Manufacturing. Products manufactured and processed in the commonwealth have a *value added by manufacture* of about $26 billion a year. This figure represents the increase in value of raw materials after they become finished products.

About 2,000 factories operate in Puerto Rico. Many were set up under the *Operation Bootstrap* program for



Odyssey Productions

Pineapple harvesters pick pineapples and then put them on a conveyor belt that carries the fruit to a truck. Puerto Rico produces many varieties of fruits.



Brian Parker, Tom Stack & Assoc.

Bottles of rum line a conveyor belt at a plant near Cataño. These people are checking the bottles before packaging. Puerto Rico exports large quantities of rum each year.

economic development. The commonwealth government helped the owners of the factories find locations, finance construction, and train workers.

Factories in Puerto Rico manufacture and process a great variety of products. Leading manufactured products include chemicals—especially pharmaceuticals—food products, electrical equipment, machinery, medical and scientific instruments, and clothing. Other important manufactured products of Puerto Rico include rubber and plastic products; stone, clay, and glass products; fabricated metals; printed materials; leather and leather products; and tobacco products. *Centrales* (sugar mills) in Puerto Rico produce raw sugar from the sugar cane grown on the island.

Agriculture. About 40 percent of Puerto Rico's total land area is suitable for farming. Much fertilizer must be used to enrich the fields, because the land has been worked hard for hundreds of years. Irrigation provides water for farms located in the drier southern parts of the island. Irrigation is also used on farms along the northwest coast of Puerto Rico.

Milk, poultry, and eggs are Puerto Rico's most valuable livestock products. Farmers also raise beef cattle. Puerto Rico has rapidly increased its production of livestock to help feed its growing city populations.

Coffee is the leading crop in Puerto Rico. Coffee beans are grown in the western part of the central mountains. Nearly half of Puerto Rico's farmworkers are employed in coffee farming.

Bananas are Puerto Rico's most important commercial fruit. Pineapples are grown in the coastal lowlands, especially in the north. Other fruits grown in Puerto Rico include avocados, coconuts, oranges and other citrus fruits, and plantains. Sugar cane is grown in the coastal lowlands of the island.

Mining. Stone, sand and gravel, and lime rank as Puerto Rico's most valuable mined products. Other mined products include clays and salt.

Fishing industry. Puerto Rico has an annual fish catch valued at about $21 million. About 11 million pounds (5 million kilograms) of fish and shellfish are caught yearly. Lobster is the most valuable catch.

Trade between Puerto Rico and the United States is governed by the same laws and regulations as trade between the states of the United States. Puerto Ricans do not pay customs duties on imports from the United

Economy of Puerto Rico

This map shows the major uses of land in Puerto Rico. It also shows where the leading farm, fishing, and mineral products are produced. Manufacturing is Puerto Rico's single most important economic activity. The island's chief manufacturing centers are shown in red on the map.



WORLD BOOK map

States, as they do on imports from other countries.

In the past, Puerto Rico's most important exports were sugar, molasses, and rum. Of these, only rum is still exported in large quantities. Today, Puerto Rico also exports pharmaceuticals, computer and electronic products, refined petroleum products, medical and scientific instruments, metal products, leather products, clothing, and tobacco products. Puerto Rico's chief imports are chemicals, crude petroleum, electrical machinery, food products, and transportation equipment.

San Juan, Ponce, and Mayagüez have *foreign trade zones* where owners can process, store, and reship their goods without paying customs duties. See **Free trade zone.**

Electric power is produced and sold on the island by the Puerto Rico Electric Power Authority, a public corporation created in 1941. Electric power is produced by power plants that burn petroleum, and also in small amounts by hydroelectric plants.

Transportation. Puerto Rico has over 14,000 miles (22,500 kilometers) of surfaced roads. These roads provide good transportation by automobile, bus, and truck throughout the island.

Puerto Rico's three chief seaports are San Juan in the north, Ponce in the south, and Mayagüez in the west. The largest airport is Luis Muñoz Marín International Airport in San Juan.

Communication. Puerto Rico's first newspaper, *El Día,* was founded at Ponce in 1909. Today, chief newspapers include *El Nuevo Día, El Vocero,* and the *San Juan Star,* all of which are published in San Juan. Mayagüez's *La Estella de Puerto Rico* is also a leading paper.

Puerto Rico's first radio station, WKAQ, began broadcasting from San Juan in 1922. WKAQ built Puerto Rico's first television station in 1954 in San Juan. Today, the commonwealth has about 120 radio stations and about 25 television stations. Many of the island's households receive cable television service. Most cable programming is broadcast in English.

History

Spanish rule. Christopher Columbus sailed to Puerto Rico in 1493 on his second voyage to the Western Hemisphere. Spaniards, led by Juan Ponce de León, began the first European settlement on the island in 1508. Ponce de León became the first governor in 1509. The Borinquen, or Arawak, Indians who lived there rose against the settlers, but all the revolts failed. By the mid-1500's, most of the Indians had been killed or enslaved, or had died of disease.

The island colony suffered for hundreds of years from hurricanes and plagues. It was attacked by the Carib Indians, who lived on nearby islands, and by the Dutch, English, and French. Still, the Spanish population slowly grew, fortifications and towns were built, and agriculture increased. After about 1850, the desire for greater freedom from Spain grew among Puerto Rico's people. In 1897, Spain provided for a large amount of local rule, and a new Puerto Rican government was set up in 1898 shortly before the start of the Spanish-American War.

United States rule. On July 25, 1898, U.S. forces began to land in Puerto Rico after bombarding San Juan. Spain surrendered Puerto Rico to the United States in the Treaty of Paris, which was signed on Dec. 10, 1898.



Granger Collection

Juan Ponce de León, a Spanish explorer, sailed to Puerto Rico in 1508 and established the first European settlement there. He became the first governor of the island in 1509.

Under the temporary U.S. military government, the use of U.S. money and postage stamps on the island was made official. The first U.S. civil governor was appointed by President William McKinley under the terms of the Organic Act of 1900, known as the Foraker Act.

The United States built dams, hospitals, roads, and schools. But the economy depended on agriculture, and U.S. firms owned and received much of the profits from the best plantations and largest sugar mills.

In 1917, the second Organic Act, or Jones Act, gave U.S. citizenship to Puerto Ricans. The island contributed troops to the U.S. armed forces in World War I (1914-1918) and World War II (1939-1945). During the Korean War (1950-1953), the U.S. Army's 65th Infantry Regiment, made up of Puerto Ricans, won fame for its courage and daring. Puerto Rican soldiers also participated in the Vietnam War (1957-1975) and the Persian Gulf War (1991).

Building a democracy. In the early 1940's, Puerto Rican leaders, with aid from the United States, began a program to improve living conditions on the island. The program became known as Operation Bootstrap. Large farms were broken up, and land was redistributed among farmworkers. An improved educational program rapidly reduced the number of Puerto Ricans who could not read and write. Thousands of old slum dwellings were torn down and replaced by modern housing.

On July 25, 1946, President Harry S. Truman appointed Jesús Toribio Piñero the first island-born governor of Puerto Rico. In 1947, Congress expanded Puerto Rican



Puerto Rico became a U.S. commonwealth on July 25, 1952. A flag-raising ceremony, *shown here,* celebrated the occasion.

UPI/Bettmann Newsphotos

self-government by permitting the islanders to elect their own governor. Luis Muñoz Marín was elected governor in 1948. His Popular Democratic Party favored a commonwealth linked to the United States.

In 1950, Congress passed Public Law 600, which gave Puerto Rico the power to write its own constitution. Puerto Ricans approved the law in a referendum vote in 1951. A Puerto Rican convention then wrote a constitution modeled on that of the United States, and the Puerto Rican people approved it. The U.S. Congress approved the constitution on July 1, 1952, and on July 25 Puerto Rico became a self-governing commonwealth.

During the 1950's, a sharp rise occurred in Puerto Rican migration to the U.S. mainland. Thousands of islanders moved to New York City and other large mainland cities in search of jobs. Many could not speak English and had difficulty adjusting to their new life.

Puerto Rico today continues to benefit from rapid industrial growth during the 1960's and 1970's. The Economic Development Administration, known in Spanish as *Fomento,* has helped businesses establish thousands of factories. Industrial growth has reduced unemployment. But the unemployment rate is still about three times as high as the U.S. rate. Puerto Rico also stresses cultural development, through government-sponsored events and organizations, such as the annual Casals Festival of music and the Institute of Puerto Rican Culture.

In 1964, Governor Muñoz Marín announced he would not run for a fifth term. Another Popular Democrat, Roberto Sánchez Vilella, became governor in 1965.

In 1967, Puerto Ricans voted to retain their commonwealth status rather than to become a U.S. state or an independent country. In 1968, Luis A. Ferré of the New Progressive Party was elected governor. Ferré and his party favored statehood for Puerto Rico. He ran for reelection in 1972 and was defeated by Rafael Hernández Colón, the Popular Democratic Party candidate.

Carlos Romero Barceló of the New Progressive Party was elected governor in 1976 and was reelected in 1980. In 1984, he was defeated by Hernández Colón. Hernández Colón was reelected in 1988. In 1992, Pedro J. Rosselló of the New Progressive Party was elected governor. He was reelected in 1996. The New Progressive Party was defeated by the Popular Democrats in 2000, when Sila Maria Calderon was elected the first woman governor of Puerto Rico.

Important dates in Puerto Rico

1493 Christopher Columbus sailed to Puerto Rico during his second voyage to the Western Hemisphere.

1508 Spanish colonists began settlement of Puerto Rico.

1598 The English seized San Juan and held it for five months.

1625 The Dutch burned San Juan.

1797 The English attacked San Juan.

1898 U.S. troops occupied Puerto Rico, and Spain ceded the island to the U.S. after the Spanish-American War.

1900 Congress established civil government for Puerto Rico with the first Organic Act, or Foraker Act.

1917 Puerto Ricans became citizens of the United States by the second Organic Act, or Jones Act.

1947 Congress amended the Jones Act to permit Puerto Ricans to elect their own governor.

1949 Luis Muñoz Marín was inaugurated as the first elected governor of Puerto Rico. He served until 1965.

1952 Puerto Rico adopted its constitution and became a commonwealth.

1967-1998 Puerto Rico held three referendums that resulted in the island keeping its commonwealth status.

2000 Sila Maria Calderon was elected the first woman governor of Puerto Rico.

In 1993 and 1998, Puerto Rico held referendums on whether it should remain a commonwealth. Both votes resulted in the island keeping its commonwealth status.

In September 1998, Hurricane Georges swept across Puerto Rico. This powerful storm killed three people and caused about $2 billion in damage.

Since 1941, the U.S. Navy has conducted military training activities, including bombing exercises, on the Puerto Rican island of Vieques. Many Puerto Ricans oppose the Navy's presence on Vieques and have demanded an end to the military exercises. The protests became particularly intense after a civilian security guard was killed in a bombing accident in April 1999. From then to May 2000, protesters occupied the Navy bombing range, forcing a suspension of the bombing. Exercises resumed in June 2000. Fernando Bayrón-Toro

Related articles in *World Book* include:

Aponte Martinez, Luis Cardinal
Clemente, Roberto
Muñoz Marín, Luis
Ponce de León, Juan
San Juan
Spanish-American War

Outline

I. Government
- A. Commonwealth government
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- J. Communication

VIII. History

Questions

What are the three largest cities in Puerto Rico?
When did Christopher Columbus reach the island?
What is Operation Bootstrap?
When do the children of Puerto Rico get their Christmas gifts?
Why is climate an important natural resource for the island?
What are Puerto Rico's most valuable crops?
How did Puerto Rico become a U.S. territory?
What is the coquí? El Yunque?
Who was Luis Muñoz Marín?
What are Puerto Rico's chief exports?

Additional resources

Level I

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Puff adder. See Adder.

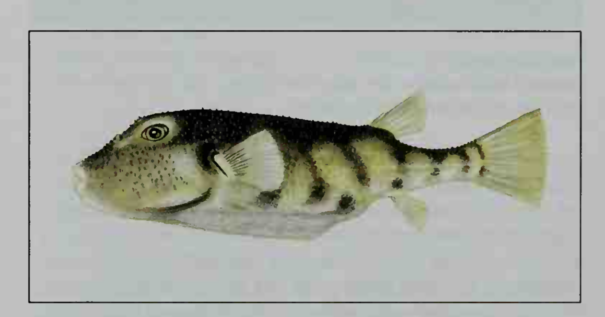
Puffball is the name of a group of fungi that produce ball- or pear-shaped fruit with completely enclosed spores. Many puffballs have white flesh. They are edible until the developing spores begin to color the flesh. When a puffball is mature, the inside is a mass of powdery, yellowish, purplish, or olive-colored spores. Sometimes an opening, or crater, develops in the top of a puffball. Clouds of tiny spores that look like puffs of smoke may come out through the opening when the fruit is touched or squeezed. For this reason, one kind of puffball is called the *devil's snuffbox.* Joe F. Ammirati

Scientific classification. Most puffballs belong to the puffball family, Lycoperdaceae.

Puffer is a type of fish that can inflate its body like a balloon. Puffers normally measure from 2 inches (5 centimeters) to nearly 2 feet (60 centimeters) in length. These fish can greatly expand their stomachs and take on the shape of a ball by rapidly swallowing water or air. Puffers frequently inflate their bodies to protect themselves from their enemies.

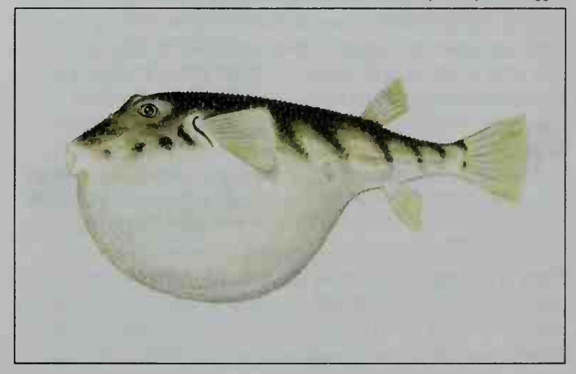
There are about 120 kinds of puffers. They have greatly modified scales and many have smooth, leathery skin. Some puffers have prickles on their underside that appear only when the fish inflates its body. Certain small puffers have a long, narrow snout. All puffers have strong upper and lower teeth that form a beak. Puffers use their teeth to tear coral or crush the shells of various sea animals. Puffers eat shellfish, such as clams, crabs, and shrimp.

Most puffers live in warm oceans. A few varieties are



The puffer becomes twice its normal size and floats on the surface of the water when it inflates its stomach.

WORLD BOOK illustrations of a northern puffer by John F. Eggert



found in rivers and other fresh water. Some puffers can be eaten, but most are poisonous. In Japan, puffer is known as *fugu* and considered a rare and tasty dish. Some puffers do well in home aquariums.

Leighton R. Taylor, Jr.

Scientific classification. Puffers belong to the family Tetraodontidae.

Puffin, also called *sea parrot,* is an odd-looking bird that lives in the Arctic waters of the Atlantic and Pacific oceans. It has a thick body, a large head, and a high, flattened bill. The three major species of puffins are the *Atlantic puffin,* the *horned puffin,* and the *tufted puffin.*



© Jeff Lepore, Photo Researchers

Horned puffins spend the summer on the Pacific coasts of Alaska and Russia, where they raise their young. The rest of the year, they live in the North Pacific Ocean.

During the breeding season, colored growths form on the male puffin's beak. Atlantic and horned puffins have white feathers on the breast, throat, underparts, and sides of the head. They have blackish feathers on the wings, tail, and forepart of the neck. The tufted puffin is dark underneath, with a white-streaked plume on the side of the head.

Puffins feed chiefly on fish. They are expert swimmers and divers and come to land mainly in June and July, during the breeding season. Puffins make their nests in large colonies on rocky coasts and islands. The female lays one white egg in a burrow or crevice in the rocks. The chick stays in the burrow for 7 to 8 weeks after hatching. The chick then emerges and learns how to feed on its own. Donald F. Bruning

Scientific classification. Puffins belong to the auk family, Alcidae. The scientific name for the Atlantic puffin is *Fratercula arctica.* The horned puffin is *F. corniculata,* and the tufted puffin is *Lunda cirrhata.*

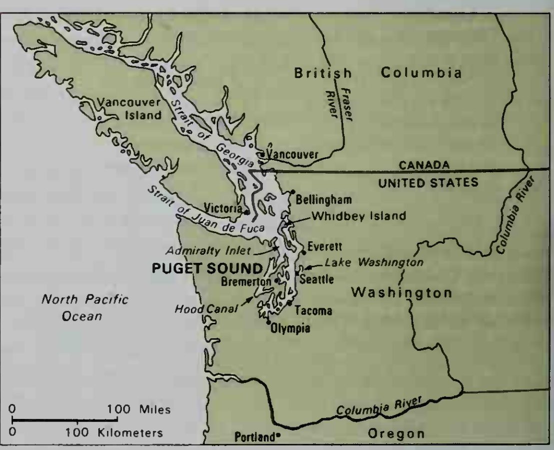
Pug is a small dog with a short nose and a tail that curls tightly over its back. It is the largest of the toy-sized dogs and weighs 14 to 18 pounds (6.4 to 8 kilograms). It has short, smooth hair and a deeply wrinkled face. It originated in China. See also **Dog** (picture: Toy dogs); **Toy dog.** Critically reviewed by the American Kennel Club

Puget, *PYOO jiht,* **Peter** (1762?-1822), a British naval officer and explorer, played an important part in the exploration of the north Pacific Coast of North America. Puget Sound, in the state of Washington, Cape Puget in Alaska, and Puget Island in the Columbia River were named for him. From 1791 to 1795, Puget sailed as a lieutenant with Captain George Vancouver on a four-year trip around the world. This voyage included a trip to Nootka Sound, near what is now Vancouver Island, to regain English territory from Spain. In 1792, they became the first Europeans to reach the sound, or arm, of the Pacific Ocean that Vancouver named for Puget. Puget explored the sound, surveyed the Yakutat Bay area on the southern Alaska coast, and helped explore Cook Inlet and Prince William Sound in the Gulf of Alaska. Barry M. Gough

See also **Vancouver, George.**

Puget Sound, *PYOO jiht,* is a large, irregular inlet in the northwest corner of the state of Washington. Puget Sound is a leading American shipping center. The ports of Seattle, Tacoma, Bremerton, Olympia, and Everett stand on its banks. The sound is 100 miles (160 kilometers) long, and covers an area of about 2,000 square miles (5,200 square kilometers). The largest ships can steam into any part of the sound, as its depth is from 180 to 925 feet (55 to 282 meters).

The Strait of Juan de Fuca links Puget Sound and the Pacific Ocean. From the meeting point of this strait and the Strait of Georgia, Puget Sound extends southward for about 35 miles (56 kilometers) before it divides into two main branches—Admiralty Inlet and the Hood Canal. The Lake Washington Ship Canal extends from Puget Sound to Lake Washington at Seattle.



WORLD BOOK map

Location of Puget Sound

Most of the sound's shores are high and wooded. Whidbey Island, one of the many islands in Puget Sound, is more than 40 miles (64 kilometers) long. Whidbey Island is one of the largest United States islands.

The sound is noted for the fisheries and lumber mills along its shores. Fish packing and canning are among the area's chief industries. The sound is the center of Washington's great lumber industry. Jois C. Child

See also **Puget, Peter.**

Pulaski, *pu LAS kee,* **Casimir,** *KAZ uh mir* (1747?-1779), a Polish nobleman and soldier, won fame for his role with the Continental Army in the Revolutionary War in America (1775-1783). He sailed to America in 1777 to offer his services to General George Washington. Pulaski was Washington's aide-de-camp at the Battle of Brandywine in September 1777. At Washington's urging, Congress made Pulaski a brigadier general. Pulaski, an expert cavalryman, organized a corps of cavalrymen that became known as Pulaski's Legion. The group performed valiantly in the South. It participated in the siege of Savannah, where Pulaski was wounded on Oct. 9, 1779. He died two days later.



Brown Bros.

Casimir Pulaski

Before coming to America, Pulaski led an unsuccessful revolt of Polish forces against Russia, which controlled Poland at that time. He learned of the American cause in France from Benjamin Franklin, who encouraged him to travel to America.

Pulaski was born in the province of Podolia, Poland, now part of Ukraine. By an act of the United States Congress, October 11 is observed as Pulaski Day. In Illinois, the first Monday in March is celebrated as Pulaski Day.

James Kirby Martin

Puli, *POO lee,* is a medium-sized sheepdog originally bred in Hungary. The puli's coat is black, rust-colored and black, white, or gray and becomes tangled into ropelike cords if allowed to grow naturally. The dog is intelligent and fun-loving. It makes an excellent pet and watchdog. The puli stands about 17 inches (43 centimeters) tall at the shoulder.

Critically reviewed by the Puli Club of America

See also **Dog** (picture: Some breeds of dogs have unusual characteristics).

Pulitzer, *PUL iht suhr* or *PYOO liht suhr,* **Joseph** (1847-1911), was a Hungarian immigrant who became one of the greatest American newspaper publishers in history. He established the Pulitzer Prizes for achievements in journalism, literature, music, and art (see **Pulitzer Prizes**).

Pulitzer was born in Mako, Hungary. His family moved to Budapest when he was young. He left home at 17 in search of military adventure, but the armed forces of Austria, Britain, and France rejected him because of his poor health and bad eyesight. A recruiter enlisted Pulitzer to fight with the Union Army in the American Civil War. After brief service, he settled in St. Louis, Missouri, became a U.S. citizen, and worked as a laborer.

His career. In 1868, Pulitzer became a reporter on a German-language newspaper in St. Louis. Within four years, he became managing editor and part owner of the paper. He won a seat in the Missouri House of Representatives in 1869. Pulitzer became a leader among the people of German descent in St. Louis and helped Horace Greeley in his 1872 presidential campaign. But three years later, Pulitzer became a Democrat and sold his interest in the newspaper, which was Republican.

In 1876 and 1877, Pulitzer served as a correspondent in Washington, D.C., for the *New York Sun.* He bought two newspapers, the *St. Louis Dispatch* and *Evening Post,* in 1878, and combined them into the *St. Louis Post-Dispatch.* Within four years, the *St. Louis Post-Dispatch* made him a fortune.

In 1883, Pulitzer bought the *New York World,* a financially troubled New York City paper. He soon transformed the *World* into a vigorous, crusading newspaper with the largest circulation in the nation, 250,000 by 1887. This paper was one of the first to use the color comics and sensationalism that gave rise to "yellow journalism" (see **Journalism** [The age of sensationalism]).

Pulitzer was almost totally blind after 1887, and also extremely sensitive to noise. From then until his death, he directed the *World* and the *Post-Dispatch* from his home with the help of secretaries.

His bequests. Pulitzer left $2 million to establish a graduate school of journalism at Columbia University. The Pulitzer Prizes were created with part of this money. He left $500,000 each to the New York Philharmonic Society and to the Metropolitan Museum of Art. Pulitzer's will also provided that the *World* should never be sold. But a court permitted the sale of the newspaper in 1931 because of financial losses. The family kept the *Post-Dispatch.*

Michael Emery

Pulitzer Prizes, *PUL iht suhr* or *PYOO liht suhr,* are awards given in the United States each year for distinguished achievement in journalism, literature, drama, and music. The prizes were established by Joseph Pulitzer, a newspaper publisher who was the founder of the *St. Louis Post-Dispatch.*

Pulitzer's will provided $2 million for Columbia University to establish a graduate school of journalism. Pulitzer specified that after the school had operated for at least three years, prizes should be awarded for the advancement of education, journalism, literature, music, public morals, and public service. The Columbia University School of Journalism was founded in 1912, and the first Pulitzer Prizes were awarded in 1917.

Prizes in journalism are awarded for material appearing in a United States newspaper published daily, Sunday, or at least once a week during the calendar year. Prizes are awarded in 14 categories. Two runners-up are also announced in each category. In all cases, preference is given to work first appearing in newspapers, and characterized by high quality of writing and reporting.

(1) For a distinguished example of meritorious public-service by a newspaper through the use of its journalistic resources, which may include cartoons, editorials, photographs, or reporting. The prize in this category is a gold medal.

(2) For a distinguished example of breaking news reporting. The prize is $7,500.

(3) For a distinguished example of investigative reporting within a newspaper's area of circulation by an individual or a team, published as a single article or a series. The prize is $7,500.

(4) For explanatory journalism that illuminates significant and complex issues. The prize is $7,500.

(5) For a distinguished example of beat reporting. The prize is $7,500.

(6) For a distinguished example of reporting on nation-

al affairs. The prize is $7,500.

(7) For a distinguished example of reporting on international affairs, including United Nations correspondence. The prize is $7,500.

(8) For a distinguished example of feature writing giving prime consideration to high literary quality and originality. The prize is $7,500.

(9) For distinguished commentary. The prize is $7,500.

(10) For distinguished criticism. The prize is $7,500.

(11) For distinguished editorial writing. Consideration is given to clarity of style, moral purpose, sound reasoning, and power to influence public opinion in what the writer feels is the right direction. All the editorial writer's work during the year is taken into account. The prize is $7,500.

(12) For a distinguished example of a cartoonist's work. The cartoon should express an idea clearly, show good drawing and striking pictorial effect, and be intended to help some worthy cause of public importance. Consideration is given to all the artist's work during the year. The prize is $7,500.

(13) For an outstanding example of spot news photography in black and white or in color. An entry may consist of a photograph or photographs, a sequence, or an album. The prize is $7,500.

(14) For an outstanding example of feature photography in black and white or in color. An entry may consist of a photograph or photographs, a sequence, or an album. The prize is $7,500.

Prizes in literature, drama, and music. Awards in literature are made for works published during the calendar year. Awards for drama and music cover the 12 months from March 15 to March 14. Prizes are awarded in seven categories. Two runners-up are also announced in each category.

(1) For distinguished fiction published in book form by an American author, preferably dealing with American life. The prize is $7,500.

(2) For a distinguished play by an American author, preferably original in its source and dealing with American life. The prize is $7,500.

(3) For a distinguished book on the history of the United States. The prize is $7,500.

(4) For a distinguished biography or autobiography by an American author. The prize is $7,500.

(5) For a distinguished book of verse by an American author. The prize is $7,500.

(6) For a distinguished book of nonfiction by an American author, giving prime consideration to high literary quality and originality. The prize is $7,500.

(7) For a distinguished composition by an American in chamber, orchestral, or choral music; or for an opera or ballet. The work must have had its first American performance during the 12-month period under consideration. The prize is $7,500.

Special citations are sometimes awarded to honor a single achievement or an entire career. Both individuals and organizations have received citations.

Award procedures. Anyone may recommend a work for a Pulitzer Prize by writing to the Pulitzer Prize Office, 709 Journalism, Columbia University, New York, NY 10027. Entries for literature prizes must be made on or before November 1 of the year under consideration. Four copies of each work must be submitted.

Entries for journalism prizes must be made on or before February 1 following the year for which the work is being judged. Each entry must be accompanied by an exhibit in scrapbook form of news stories, editorials, photographs, or cartoons as published. The exhibit must be accompanied by the name and date of the paper and reasons why the work is being recommended. Except under special circumstances, exhibits in the public service category and both photography categories are limited to 20 articles or pictures. In feature writing, the limit is 5 articles. In the remaining journalism categories, the limit is 10 articles, editorials, or cartoons.

Pulitzer Prizes are awarded annually in April by Columbia University on the recommendation of the Pulitzer Prize Board. There are 16 voting members on the board. The permanent members are the president of Columbia University and Joseph Pulitzer, Jr., grandson of the founder of the prizes. The other members serve a maximum of three terms of three years each. A permanent administrator serves as secretary of the board. The board chooses each of its members.

With the approval of the board, Columbia University recommends juries to vote on entries in all categories. Jurors are appointed for one year at a time. Most journalism juries consist of five journalists. Most literature juries consist of three distinguished writers, critics, or academic authorities for each category. Most music juries are made up of composers and music critics. Each jury makes three nominations to the board. The nominations are listed in alphabetical order. The board may accept or reject the findings of any jury or make substitute recommendations.

No person may serve on a jury if he or she could benefit from the selection of a particular winner. Any board member having any interest in any jury nomination must leave the room while a vote on the award in that category is taken.

If the board feels that no nominated book, play, musical composition, or journalistic work is worth a prize, the prize may be withheld. Robin H. Kuzen

See also **Pulitzer, Joseph.**

Additional resources

Brennan, Elizabeth A., and Clarage, E. C. *Who's Who of Pulitzer Prize Winners.* Oryx, 1999.

Rothmyer, Karen. *Winning Pulitzers: The Stories Behind Some of the Best News Coverage of Our Time.* Columbia Univ. Pr., 1991.

Pulitzer Prizes in journalism

Meritorious public service

1917	No award.
1918	*The New York Times.*
1919	*The Milwaukee Journal.*
1920	No award.
1921	*Boston Post.*
1922	*The World* (New York).
1923	*The Commercial Appeal* (Memphis).
1924	*The World* (New York).
1925	No award.
1926	*The Enquirer Sun* (Columbus, Ga.).
1927	*Canton* (Ohio) *Daily News.*
1928	*Indianapolis Times.*
1929	*The Evening World* (New York).
1930	No award.
1931	*The Atlanta Constitution.*
1932	*Indianapolis News.*
1933	*New York World-Telegram.*

1934 *Mail Tribune* (Medford, Ore.).
1935 *The Sacramento* (Calif.) *Bee.*
1936 *The Cedar Rapids* (Iowa) *Gazette.*
1937 *St. Louis Post-Dispatch.*
1938 *The Bismarck* (N. Dak.) *Tribune.*
1939 *The Miami* (Fla.) *Daily News.*
1940 *Waterbury* (Conn.) *Republican and American.*
1941 *St. Louis Post-Dispatch.*
1942 *Los Angeles Times.*
1943 *The World-Herald* (Omaha).
1944 *The New York Times.*
1945 *Detroit Free Press.*
1946 *The Scranton* (Pa.) *Times.*
1947 *The Sun* (Baltimore).
1948 *St. Louis Post-Dispatch.*
1949 *Nebraska State Journal* (Lincoln).
1950 *Chicago Daily News; St. Louis Post-Dispatch.*
1951 *The Miami* (Fla.) *Herald; Brooklyn Daily Eagle.*
1952 *St. Louis Post-Dispatch.*
1953 *The News Reporter* (Whiteville, N.C.); *Tabor City* (N.C.) *Tribune.*
1954 *Newsday* (Garden City, N.Y.).
1955 *Columbus* (Ga.) *Ledger and Sunday Ledger-Enquirer.*
1956 *Register-Pajaronian* (Watsonville, Calif.).
1957 *Chicago Daily News.*
1958 *Arkansas Gazette* (Little Rock).
1959 *Observer-Dispatch* (Utica, N.Y.); *Utica Daily Press.*
1960 *Los Angeles Times.*
1961 *Amarillo* (Tex.) *Globe-Times.*
1962 *The Panama City* (Fla.) *News-Herald.*
1963 *Chicago Daily News.*
1964 *St. Petersburg* (Fla.) *Times.*
1965 *The Hutchinson* (Kans.) *News.*
1966 *The Boston Globe.*
1967 *The Courier-Journal* (Louisville, Ky.); *The Milwaukee Journal.*
1968 *The Riverside* (Calif.) *Press-Enterprise.*
1969 *Los Angeles Times.*
1970 *Newsday* (Garden City, N.Y.).
1971 *Winston-Salem* (N.C.) *Journal and Sentinel.*
1972 *The New York Times.*
1973 *The Washington* (D.C.) *Post.*
1974 *Newsday* (Garden City, N.Y.).
1975 *The Boston Globe.*
1976 *Anchorage* (Alaska) *Daily News.*
1977 *Lufkin* (Tex.) *News.*
1978 *The Philadelphia Inquirer.*
1979 *Point Reyes* (Calif.) *Light.*
1980 Gannett News Service.
1981 *Charlotte* (N.C.) *Observer.*
1982 *The Detroit News.*
1983 *The Clarion-Ledger* (Jackson, Miss.).
1984 *Los Angeles Times.*
1985 *Fort Worth* (Tex.) *Star-Telegram.*
1986 *The Denver Post.*
1987 *Pittsburgh Press.*
1988 *Charlotte* (N.C.) *Observer.*
1989 *Anchorage* (Alaska) *Daily News.*
1990 *The Philadelphia Inquirer; The Washington* (N.C.) *Daily News.*
1991 *The Des Moines* (Iowa) *Register.*
1992 *The Sacramento* (Calif.) *Bee.*
1993 *The Miami Herald.*
1994 *Akron* (Ohio) *Beacon Journal.*
1995 *Daily News* (Virgin Islands).
1996 *The News and Observer* (Raleigh, N.C.).
1997 *The Times-Picayune* (New Orleans).
1998 *Grand Forks* (N. Dak.) *Herald.*
1999 *The Washington* (D.C.) *Post.*
2000 *The Washington* (D.C.) *Post.*
2001 *The Oregonian* (Portland).
2002 *The New York Times.*

Reporting

1917 Herbert B. Swope, *The World* (New York).
1918 Harold A. Littledale, *New York Evening Post.*
1919 No award.
1920 John J. Leary, Jr., *The World* (New York).
1921 Louis Seibold, *The World* (New York).
1922 Kirke L. Simpson, The Associated Press.
1923 Alva Johnston, *The New York Times.*
1924 Magner White, *San Diego* (Calif.) *Sun.*
1925 James W. Mulroy, Alvin H. Goldstein, *Chicago Daily News.*
1926 William B. Miller, *The Courier-Journal* (Louisville, Ky.).
1927 John T. Rogers, *St. Louis Post-Dispatch.*
1928 No award.
1929 Paul Y. Anderson, *St. Louis Post-Dispatch.*
1930 Russell D. Owen, *The New York Times.*
1931 A. B. MacDonald, *The Kansas City* (Mo.) *Star.*
1932 W. C. Richards, D. D. Martin, J. S. Pooler, F. D. Webb, J. N. W. Sloan, *Detroit Free Press.*
1933 Francis A. Jamieson, The Associated Press.
1934 Royce Brier, *San Francisco Chronicle.*
1935 William H. Taylor, *New York Herald Tribune.*
1936 Lauren D. Lyman, *The New York Times.*
1937 John O'Neill, *New York Herald Tribune;* William Laurence, *New York Times;* Howard Blakeslee, Associated Press; Gobind Behari Lal, Universal Service; David Dietz, Scripps-Howard Newspapers.
1938 Raymond Sprigle, *Pittsburgh Post-Gazette.*
1939 Thomas L. Stokes, Scripps-Howard Newspaper Alliance.
1940 S. Burton Heath, *New York World-Telegram.*
1941 Westbrook Pegler, *New York World-Telegram.*
1942 Stanton Delaplane, *San Francisco Chronicle.*
1943 George Weller, *Chicago Daily News.*
1944 Paul Schoenstein and associates, *New York Journal-American.*
1945 Jack S. McDowell, *The Call-Bulletin* (San Francisco).
1946 William L. Laurence, *The New York Times.*
1947 Frederick Woltman, *New York World-Telegram.*
1948 George E. Goodwin, *The Atlanta Journal.*
1949 Malcolm Johnson, *The Sun* (New York).
1950 Meyer Berger, *The New York Times.*
1951 Edward S. Montgomery, *San Francisco Examiner.*
1952 George de Carvalho, *San Francisco Chronicle.*
1953 Award divided into the following two categories.

Local reporting (Under pressure of edition time)

1953 *The Providence* (R.I.) *Journal and Evening Bulletin.*
1954 *Vicksburg* (Miss.) *Sunday Post-Herald.*
1955 Caro Brown, *Alice* (Tex.) *Daily Echo.*
1956 Lee Hills, *Detroit Free Press.*
1957 *Salt Lake* (Utah) *Tribune.*
1958 *Fargo* (N. Dak.) *Forum.*
1959 Mary Lou Werner, *The Evening Star* (Washington).
1960 Jack Nelson, *The Atlanta Constitution.*
1961 Sanche de Gramont, *New York Herald Tribune.*
1962 Robert D. Mullins, *The Deseret News* (Salt Lake City, Utah).
1963 Sylvan Fox, William Longgood, and Anthony Shannon, *The New York World-Telegram & Sun.*
1964 Award became local general or spot news reporting.

Local reporting (Not under pressure of edition time)

1953 Edward J. Mowery, *The New York World-Telegram & Sun.*
1954 Alvin S. McCoy, *The Kansas City* (Mo.) *Star.*
1955 Roland K. Towery, *Cuero* (Tex.) *Record.*
1956 Arthur Daley, *The New York Times.*
1957 Wallace Turner and William Lambert, *The Oregonian* (Portland).
1958 George Beveridge, *The Evening Star* (Washington).
1959 John H. Brislin, *Scranton* (Pa.) *Tribune* and *Sunday Scrantonian.*
1960 Miriam Ottenberg, *The Evening Star* (Washington).
1961 Edgar May, *Buffalo* (N.Y.) *Evening News.*
1962 George Bliss, *Chicago Tribune.*
1963 Oscar Griffin, Jr., *Pecos* (Tex.) *Independent Enterprise.*
1964 Award became local specialized reporting.

Local general or spot news reporting

1964 Norman C. Miller, Jr., *The Wall Street Journal.*
1965 Melvin H. Ruder, *Hungry Horse News* (Columbia Falls, Mont.).
1966 The staff of the *Los Angeles Times.*
1967 Robert V. Cox, *Public Opinion* (Chambersburg, Pa.).
1968 The staff of the *Detroit Free Press.*
1969 John Fetterman, *The Courier-Journal* (Louisville, Ky.).
1970 Thomas Fitzpatrick, *Chicago Sun-Times.*
1971 The staff of the *Akron* (Ohio) *Beacon Journal.*
1972 Richard I. Cooper and John W. Machacek, *The Rochester* (N.Y.) *Times-Union.*
1973 The staff of the *Chicago Tribune.*
1974 Art Petacque and Hugh Hough, *Chicago Sun-Times.*
1975 The staff of *The Xenia* (Ohio) *Daily Gazette.*
1976 Gene Miller, *The Miami Herald.*
1977 Margo Huston, *The Milwaukee Journal.*
1978 Richard Whitt, *The Courier-Journal* (Louisville, Ky.).
1979 The staff of the *San Diego Evening Tribune.*
1980 The staff of *The Philadelphia Inquirer.*
1981 The staff of *The Daily News* (Longview, Wash.).
1982 The staffs of *The Kansas City* (Mo.) *Star* and *The Kansas City* (Mo.) *Times.*
1983 The staff of *The News-Sentinel* (Fort Wayne, Ind.).
1984 The staff of *Newsday* (Melville, N.Y.)
1985 Award became general news reporting.

General news reporting

1985 Thomas Turcol, *The Virginian-Pilot* and *The Ledger-Star* (Norfolk, Va.).
1986 Edna Buchanan, *The Miami Herald.*
1987 The staff of the *Akron* (Ohio) *Beacon Journal.*
1988 The staff of *The Alabama Journal* (Montgomery, Ala.); the staff of *The Eagle-Tribune* (Lawrence, Mass.).
1989 The staff of *The Courier-Journal* (Louisville, Ky.).
1990 The staff of the *San Jose Mercury News.*
1991 Award became spot news reporting.

Spot news reporting

1991 The staff of *The Miami Herald.*
1992 The staff of *Newsday* (Melville, N.Y.).
1993 The staff of the *Los Angeles Times.*
1994 The staff of *The New York Times.*

1995 The staff of the *Los Angeles Times.*
1996 Robert D. McFadden, *The New York Times.*
1997 The staff of *Newsday* (Melville, N.Y.).
1998 Award became breaking news reporting.

Breaking news reporting

1998 The staff of the *Los Angeles Times.*
1999 The staff of *The Hartford Courant.*
2000 The staff of *The Denver Post.*
2001 The staff of *The Miami* (Fla.) *Herald.*
2002 The staff of *The Wall Street Journal.*

Local specialized reporting

1964 Albert V. Gaudiosi, James V. Magee, and Frederick A. Meyer, *The Philadelphia Bulletin.*
1965 Gene Goltz, *The Houston Post.*
1966 John A. Frasca, *Tampa* (Fla.) *Tribune.*
1967 Gene Miller, *The Miami* (Fla.) *Herald.*
1968 J. Anthony Lukas, *The New York Times.*
1969 Albert L. Delugach, Denny Walsh, *St. Louis Globe-Democrat.*
1970 Harold Eugene Martin, *The Montgomery* (Ala.) *Journal.*
1971 William Hugh Jones, *Chicago Tribune.*
1972 Ann DeSantis, Stephen A. Kurkjian, Timothy Leland, and Gerard M. O'Neill, *The Boston Globe.*
1973 The staff of the Sun Newspapers, Omaha, Nebr.
1974 William Sherman, *Daily News* (N.Y.)
1975 The staff of *The Indianapolis Star.*
1976 The staff of the *Chicago Tribune.*
1977 Acel Moore, Wendell Rawls, Jr., *The Philadelphia Inquirer.*
1978 Anthony R. Dolan, *The Stamford* (Conn.) *Advocate.*
1979 Gilbert M. Gaul and Elliot G. Jaspin, *Pottsville* (Pa.) *Republican.*
1980 Nils Bruzelius, Alexander B. Hawes, Jr., Stephen A. Kurkjian, Robert Porterfield, and Joan Vennochi, *The Boston Globe.*
1981 Clark Hallas and Robert B. Lowe, *The Arizona Daily Star* (Tucson).
1982 Paul Henderson, *The Seattle Times.*
1983 Loretta Tofani, *The Washington* (D.C.) *Post.*
1984 The staff of *The Boston Globe.*
1985 Award became investigative reporting.

Investigative reporting

1985 Lucy Morgan and Jack Reed, *St. Petersburg* (Fla.) *Times;* William K. Marimow, *The Philadelphia Inquirer.*
1986 Jeffrey A. Marx and Michael M. York, *Lexington* (Ky.) *Herald-Leader.*
1987 Daniel R. Biddle, H. G. Bissinger, and Frederic N. Tulsky, *The Philadelphia Inquirer;* John Woestendiek, *The Philadelphia Inquirer.*
1988 Dean Baquet, William C. Gaines, and Ann Marie Lipinski, *Chicago Tribune.*
1989 Bill Dedman, *The Atlanta Journal* and *The Atlanta Constitution.*
1990 Lou Kilzer and Chris Ison, *Minneapolis Star Tribune.*
1991 Joseph T. Hallinan and Susan M. Headden, *The Indianapolis Star.*
1992 Lorraine Adams and Dan Malone, *The Dallas Morning News.*
1993 Jeff Brazil and Steve Berry, *The Orlando* (Fla.) *Sentinel.*
1994 The staff of *The Providence* (R.I.) *Journal-Bulletin.*
1995 Stephanie Saul and Brian Donovan, *Newsday* (Melville, N.Y.).
1996 The staff of *The Orange County* (Cal.) *Register.*
1997 Eric Nalder, Deborah Nelson, and Alex Tizon, *The Seattle Times.*
1998 Gary Cohn and Will Englund, *The Sun* (Baltimore).
1999 The staff of *The Miami* (Fla.) *Herald.*
2000 Sang-Hun Choe, Charles J. Hanley, and Martha Mendoza, The Associated Press.
2001 David Willman, *Los Angeles Times.*
2002 Sari Horwitz, Scott Higham, and Sarah Cohen, *The Washington* (D.C.) *Post.*

National reporting

1942 Louis Stark, *The New York Times.*
1943 No award.
1944 Dewey L. Fleming, *The Sun* (Baltimore).
1945 James B. Reston, *The New York Times.*
1946 Edward A. Harris, *St. Louis Post-Dispatch.*
1947 Edward T. Folliard, *The Washington* (D.C.) *Post.*
1948 Bert Andrews, *New York Herald Tribune;* Nat S. Finney, *The Minneapolis Tribune.*
1949 Charles P. Trussell, *The New York Times.*
1950 Edwin O. Guthman, *The Seattle Times.*
1951 No award.
1952 Anthony Leviero, *The New York Times.*
1953 Don Whitehead, The Associated Press.
1954 Richard L. Wilson, *The Register & Tribune* (Des Moines, Iowa).
1955 Anthony Lewis, *Washington* (D.C.) *Daily News.*
1956 Charles L. Bartlett, *The Chattanooga* (Tenn.) *Times.*
1957 James B. Reston, *The New York Times.*
1958 Relman Morin, The Associated Press; Clark Mollenhoff, *The Register & Tribune* (Des Moines, Iowa).
1959 Howard Van Smith, *Miami* (Fla.) *News.*
1960 Vance Trimble, Scripps-Howard Newspaper Alliance.
1961 Edward R. Cony, *The Wall Street Journal.*
1962 Nathan G. Caldwell and Gene S. Graham, *The Tennessean* (Nashville).
1963 Anthony Lewis, *The New York Times.*
1964 Merriman Smith, United Press International.
1965 Louis M. Kohlmeier, *The Wall Street Journal.*
1966 Haynes Johnson, *The Evening Star* (Washington).
1967 Monroe W. Karmin and Stanley Penn, *The Wall Street Journal.*
1968 Howard James, *The Christian Science Monitor;* Nathan K. Kotz, *The Des Moines* (Iowa) *Register.*
1969 Robert Kahn, *The Christian Science Monitor.*
1970 William J. Eaton, *Chicago Daily News.*
1971 Lucinda Franks and Thomas Powers, United Press International.
1972 Jack Anderson, syndicated columnist.
1973 Robert Boyd and Clark Hoyt, Knight Newspapers.
1974 James R. Polk, *Star-News* (Washington, D.C.); Jack White, *The Providence* (R.I.) *Journal* and *Evening Bulletin.*
1975 Donald L. Barlett and James B. Steele, *The Philadelphia Inquirer.*
1976 James Risser, *The Des Moines* (Iowa) *Register.*
1977 Walter Mears, The Associated Press.
1978 Gaylord D. Shaw, *Los Angeles Times.*
1979 James Risser, *The Des Moines* (Iowa) *Register.*
1980 Bette Swenson Orsini and Charles Stafford, *St. Petersburg* (Fla.) *Times.*
1981 John M. Crewdson, *The New York Times.*
1982 Rick Atkinson, *The Kansas City* (Mo.) *Times.*
1983 The staff of *The Boston Globe.*
1984 John Noble Wilford, *The New York Times.*
1985 Thomas J. Knudson, *The Des Moines* (Iowa) *Register.*
1986 Craig Flournoy and George Rodrigue, *Dallas Morning News;* Arthur Howe, *The Philadelphia Inquirer.*
1987 The staff of *The New York Times;* the staff of *The Miami Herald.*
1988 Tim Weiner, *The Philadelphia Inquirer.*
1989 Donald L. Barlett and James B. Steele, *The Philadelphia Inquirer.*
1990 Ross Anderson, Bill Dietrich, Mary Ann Gwinn, and Eric Nalder, *The Seattle Times.*
1991 Marjie Lundstrom and Rochelle Sharpe, Gannett News Service.
1992 Jeff Taylor and Mike McGraw, *The Kansas City* (Mo.) *Star.*
1993 David Maraniss, *The Washington* (D.C.) *Post.*
1994 Eileen Welsome, *The Albuquerque* (N. Mex.) *Tribune.*
1995 Tony Horwitz, *The Wall Street Journal.*
1996 Alix M. Freedman, *The Wall Street Journal.*
1997 The staff of *The Wall Street Journal.*
1998 Russell Carollo and Jeff Nesmith, *Dayton* (Ohio) *Daily News.*
1999 The staff of *The New York Times.*
2000 The staff of *The Wall Street Journal.*
2001 The staff of *The New York Times.*
2002 The staff of *The Washington* (D.C.) *Post.*

International reporting

1942 Laurence E. Allen, The Associated Press.
1943 Ira Wolfert, North American Newspaper Alliance.
1944 Daniel DeLuce, The Associated Press.
1945 Mark S. Watson, *The Sun* (Baltimore).
1946 Homer W. Bigart, *New York Herald Tribune.*
1947 Eddy Gilmore, The Associated Press.
1948 Paul W. Ward, *The Sun* (Baltimore).
1949 Price Day, *The Sun* (Baltimore).
1950 Edmund Stevens, *The Christian Science Monitor.*
1951 Keyes Beech, Fred Sparks, *Chicago Daily News;* Homer Bigart, Marguerite Higgins, *New York Herald Tribune;* Relman Morin, Don Whitehead, The Associated Press.
1952 John M. Hightower, The Associated Press.
1953 Austin C. Wehrwein, *The Milwaukee Journal.*
1954 Jim G. Lucas, The Scripps-Howard Newspapers.
1955 Harrison E. Salisbury, *The New York Times.*
1956 William R. Hearst, Jr., Frank Conniff, Kingsbury Smith, International News Service.
1957 Russell Jones, The United Press.
1958 *The New York Times.*
1959 Joseph Martin and Philip Santora, *Daily News* (N.Y.).
1960 A. M. Rosenthal, *The New York Times.*
1961 Lynn Heinzerling, The Associated Press.
1962 *Walter Lippmann, *New York Herald Tribune.*
1963 Hal Hendrix, *Miami* (Fla.) *News.*
1964 Malcolm W. Browne, The Associated Press, and David Halberstam, *The New York Times.*
1965 J. A. Livingston, *The Philadelphia Bulletin.*
1966 Peter Arnett, The Associated Press.
1967 R. John Hughes, *The Christian Science Monitor.*
1968 Alfred Friendly, *The Washington* (D.C.) *Post.*
1969 William Tuohy, *Los Angeles Times.*
1970 Seymour M. Hersh, Dispatch News Service.
1971 Jimmie Lee Hoagland, *The Washington* (D.C.) *Post.*
1972 Peter R. Kann, *The Wall Street Journal.*
1973 Max Frankel, *The New York Times.*
1974 Hedrick Smith, *The New York Times.*
1975 William Mullen and Ovie Carter, *Chicago Tribune.*
1976 Sidney H. Schanberg, *The New York Times.*
1977 No award.
1978 Henry Kamm, *The New York Times.*
1979 Richard Ben Cramer, *The Philadelphia Inquirer.*
1980 Joel Brinkley and Jay Mather, *The Courier-Journal* (Louisville, Ky.).
1981 Shirley Christian, *The Miami* (Fla.) *Herald.*
1982 John Darnton, *The New York Times.*

*Has a biography in *World Book.*

1983 Thomas L. Friedman, *The New York Times;* Loren Jenkins, *The Washington* (D.C.) *Post.*
1984 Karen Elliott House, *The Wall Street Journal.*
1985 Josh Friedman, Dennis Bell, and Ozier Muhammad, *Newsday* (Melville, N.Y.).
1986 Lewis M. Simons, Pete Carey, and Katherine Ellison, *San Jose Mercury News.*
1987 Michael Parks, *Los Angeles Times.*
1988 Thomas L. Friedman, *The New York Times.*
1989 Glenn Frankel, *The Washington* (D.C.) *Post;* Bill Keller, *The New York Times.*
1990 Nicholas D. Kristof and Sheryl WuDunn, *The New York Times.*
1991 Carlyle Murphy, *The Washington* (D.C.) *Post;* Serge Schmemann, *The New York Times.*
1992 Patrick J. Sloyan, *Newsday* (Melville, N.Y.).
1993 John F. Burns, *The New York Times;* Roy Gutman, *Newsday* (Melville, N.Y.).
1994 The staff of *The Dallas Morning News.*
1995 Mark Fritz, The Associated Press.
1996 David Rohde, *The Christian Science Monitor.*
1997 John F. Burns, *The New York Times.*
1998 The staff of *The New York Times.*
1999 The staff of *The Wall Street Journal.*
2000 Mark Schoofs, *The Village Voice* (New York).
2001 Ian Johnson, *The Wall Street Journal;* Paul Salopek, *Chicago Tribune.*
2002 Barry Bearak, *The New York Times.*

Explanatory reporting

1985 Jon D. Franklin, *The Evening Sun* (Baltimore).
1986 The staff of *The New York Times.*
1987 Jeff Lyon and Peter Gorner, *Chicago Tribune.*
1988 Daniel Hertzberg and James B. Stewart, *The Wall Street Journal.*
1989 David Hanners, William Snyder, and Karen Blessen, *The Dallas Morning News.*
1990 Steve Coll and David A. Vise, *The Washington* (D.C.) *Post.*
1991 Susan C. Faludi, *The Wall Street Journal.*
1992 Robert S. Capers and Eric Lipton, *The Hartford* (Conn.) *Courant.*
1993 Mike Toner, *The Atlanta Journal-Constitution.*
1994 Ronald Kotulak, *Chicago Tribune.*
1995 Leon Dash and Lucian Perkins, *The Washington* (D.C.) *Post.*
1996 Laurie Garrett, *Newsday* (Melville, N.Y.).
1997 Michael Vitez, Ron Cortes, and April Saul, *The Philadelphia Inquirer.*
1998 Paul Salopek, *Chicago Tribune.*
1999 Richard Read, *The Oregonian* (Portland).
2000 Eric Newhouse, *Great Falls* (Mont.) *Tribune.*
2001 The staff of the *Chicago Tribune.*
2002 The staff of *The New York Times.*

Specialized journalism

1985 Randall Savage and Jackie Crosby, *Macon* (Ga.) *Telegraph and News.*
1986 Andrew Schneider and Mary Pat Flaherty, *Pittsburgh Press.*
1987 Alex S. Jones, *The New York Times.*
1988 Walt Bogdanich, *The Wall Street Journal.*
1989 Edward Humes, *The Orange County* (California) *Register.*
1990 Tamar Stieber, *Albuquerque* (N. Mex.) *Journal.*
1991 Award became beat reporting.

Beat reporting

1991 Natalie Angier, *The New York Times.*
1992 Deborah Blum, *The Sacramento* (Calif.) *Bee.*
1993 Paul Ingrassia and Joseph B. White, *The Wall Street Journal.*
1994 Eric Freedman and Jim Mitzelfeld, *The Detroit News.*
1995 David M. Shribman, *The Boston Globe.*
1996 Bob Keeler, *Newsday* (Melville, N.Y.).
1997 Byron Acohido, *The Seattle Times.*
1998 Linda Greenhouse, *The New York Times.*
1999 Chuck Philips and Michael A. Hitzik, *Los Angeles Times.*
2000 George Dohrmann, *St. Paul* (Minn.) *Pioneer Press.*
2001 David Cay Johnston, *The New York Times.*
2002 Gretchen Morgenson, *The New York Times.*

Editorial writing

1917 *New York Tribune.*
1918 *The Courier-Journal* (Louisville, Ky.).
1919 No award.
1920 Harvey E. Newbranch, *Evening World-Herald* (Omaha, Nebr.).
1921 No award.
1922 Frank M. O'Brien, *The New York Herald.*
1923 *William Allen White, *The Emporia* (Kans.) *Gazette.*
1924 *The Boston Herald.* Special prize to Frank I. Cobb, *The World* (New York).
1925 *Charleston* (S.C.) *News and Courier.*
1926 Edward M. Kingsbury, *The New York Times.*
1927 F. Lauriston Bullard, *The Boston Herald.*
1928 Grover C. Hall, *Montgomery* (Ala.) *Advertiser.*
1929 Louis I. Jaffe, *Norfolk* (Va.) *Virginian-Pilot.*
1930 No award.
1931 Charles S. Ryckman, *Fremont* (Nebr.) *Tribune.*
1932 No award.
1933 *The Kansas City* (Mo.) *Star.*
1934 E. P. Chase, *Atlantic* (Iowa) *News Telegraph.*
1935 No award.
1936 Felix Morley, *The Washington* (D.C.) *Post;* George B. Parker, The Scripps-Howard Newspapers.
1937 John W. Owens, *The Sun* (Baltimore).
1938 W. W. Waymack, *The Register & Tribune* (Des Moines, Iowa).
1939 Ronald G. Callvert, *The Oregonian* (Portland).
1940 Bart Howard, *St. Louis Post-Dispatch.*
1941 Reuben Maury, *Daily News* (New York).
1942 Geoffrey Parsons, *New York Herald Tribune.*
1943 Forrest W. Seymour, *The Register & Tribune* (Des Moines, Iowa).
1944 Henry J. Haskell, *The Kansas City* (Mo.) *Star.*
1945 George W. Potter, *The Providence* (R.I.) *Journal-Bulletin.*
1946 Hodding Carter, *The Delta Democrat-Times* (Greenville, Miss.).
1947 William H. Grimes, *The Wall Street Journal.*
1948 Virginius Dabney, *Richmond* (Va.) *Times-Dispatch.*
1949 John H. Crider, *The Boston Herald;* Herbert Elliston, *The Washington* (D.C.) *Post.*
1950 Carl M. Saunders, *Jackson* (Mich.) *Citizen Patriot.*
1951 William H. Fitzpatrick, *New Orleans States.*
1952 Louis LaCoss, *St. Louis Globe-Democrat.*
1953 Vermont C. Royster, *The Wall Street Journal.*
1954 Donald M. Murray, *The Boston Herald.*
1955 Royce Howes, *The Detroit Free Press.*
1956 Lauren K. Soth, *The Register & Tribune* (Des Moines, Iowa).
1957 Buford Boone, *The Tuscaloosa* (Ala.) *News.*
1958 Harry S. Ashmore, *Arkansas Gazette* (Little Rock).
1959 Ralph McGill, *The Atlanta Constitution.*
1960 Lenoir Chambers, *The Virginian-Pilot* (Norfolk, Va.).
1961 William J. Dorvillier, *San Juan* (P.R.) *Star.*
1962 Thomas M. Storke, *Santa Barbara* (Calif.) *News-Press.*
1963 Ira B. Harkey, Jr., *Pascagoula* (Miss.) *Chronicle.*
1964 Hazel Brannon Smith, *The Lexington* (Miss.) *Advertiser.*
1965 John R. Harrison, *The Gainesville* (Fla.) *Sun.*
1966 Robert Lasch, *St. Louis Post-Dispatch.*
1967 Eugene Patterson, *The Atlanta Constitution.*
1968 John S. Knight, Knight Newspapers.
1969 Paul Greenberg, *Pine Bluff* (Ark.) *Commercial.*
1970 Philip L. Geyelin, *The Washington* (D.C.) *Post.*
1971 Horance G. Davis, Jr., *The Gainesville* (Fla.) *Sun.*
1972 John Strohmeyer, *The Bethlehem* (Pa.) *Globe-Times.*
1973 Roger B. Linscott, *The Berkshire Eagle* (Pittsfield, Mass.).
1974 F. Gilman Spencer, *The Trentonian* (Trenton, N.J.).
1975 John Daniell Maurice, *Charleston* (W. Va.) *Daily Mail.*
1976 Philip P. Kerby, *Los Angeles Times.*
1977 Warren L. Lerude, Foster Church, and Norman F. Cardoza, *Reno* (Nev.) *Evening Gazette* and *Nevada State Journal.*
1978 Meg Greenfield, *The Washington* (D.C.) *Post.*
1979 Edwin M. Yoder, Jr., *The Washington* (D.C.) *Star.*
1980 Robert L. Bartley, *The Wall Street Journal.*
1981 No award.
1982 Jack Rosenthal, *The New York Times.*
1983 The editorial board of *The Miami* (Fla.) *Herald.*
1984 Albert Scardino, *The Georgia Gazette* (Savannah).
1985 Richard Aregood, *The Philadelphia Daily News.*
1986 Jack Fuller, *Chicago Tribune.*
1987 Jonathan Freedman, *The San Diego Tribune.*
1988 Jane E. Healy, *The Orlando* (Fla.) *Sentinel.*
1989 Lois Wille, *Chicago Tribune.*
1990 Thomas J. Hylton, *The* (Pottstown, Pa.) *Mercury.*
1991 Ron Casey, Harold Jackson, and Joey Kennedy, *The Birmingham* (Ala.) *News.*
1992 Maria Henson, *Lexington* (Ky.) *Herald-Leader.*
1993 No award.
1994 R. Bruce Dold, *Chicago Tribune.*
1995 Jeffrey Good, *St. Petersburg* (Fla.) *Times.*
1996 Robert B. Semple, Jr., *The New York Times.*
1997 Michael Gartner, *The Daily Tribune* (Ames, Iowa).
1998 Bernard L. Stein, *The Riverdale* (N.Y.) *Press.*
1999 The editorial board of the *New York Daily News.*
2000 John C. Bersia, *The Orlando* (Fla.) *Sentinel.*
2001 David Moats, *Rutland* (Vt.) *Herald.*
2002 Alex Raksin and Bob Sipchen, *Los Angeles Times.*

Feature writing

1979 Jon D. Franklin, *Baltimore Evening Sun.*
1980 Madeleine Blais, *The Miami Herald.*
1981 Teresa Carpenter, *Village Voice* (New York).
1982 Saul Pett, The Associated Press.
1983 Nan Robertson, *The New York Times.*
1984 Peter Mark Rinearson, *The Seattle Times.*
1985 Alice Steinbach, *The Sun* (Baltimore).
1986 John Camp, *St. Paul* (Minn.) *Pioneer Press Dispatch.*
1987 Steve Twomey, *The Philadelphia Inquirer.*
1988 Jacqui Banaszynsky, *St. Paul* (Minn.) *Pioneer Press Dispatch.*
1989 David Zucchino, *The Philadelphia Inquirer.*
1990 Dave Curtin, *Colorado Springs* (Colo.) *Gazette-Telegraph.*
1991 Sheryl James, *St. Petersburg* (Fla.) *Times.*
1992 Howell Raines, *The New York Times.*
1993 George Lardner, Jr., *The Washington* (D.C.) *Post.*
1994 Isabel Wilkerson, *The New York Times.*

*Has a biography in *World Book.*

1995 Ron Suskind, *The Wall Street Journal.*
1996 Rick Bragg, *The New York Times.*
1997 Lisa Pollak, *The Sun* (Baltimore).
1998 Thomas French, *St. Petersburg* (Fla.) *Times.*
1999 Angelo B. Henderson, *The Wall Street Journal.*
2000 J. R. Moehringer, *Los Angeles Times.*
2001 Tom Hallman, Jr., *The Oregonian* (Portland).
2002 Barry Siegel, *Los Angeles Times.*

Criticism

1970 Ada Louise Huxtable, *The New York Times.*
1971 Harold C. Schonberg, *The New York Times.*
1972 Frank L. Peters, Jr., *St. Louis Post-Dispatch.*
1973 Ronald Powers, *Chicago Sun-Times.*
1974 Emily Genauer, Newsday Syndicate.
1975 Roger Ebert, *Chicago Sun-Times.*
1976 Alan M. Kriegsman, *The Washington* (D.C.) *Post.*
1977 William McPherson, *The Washington* (D.C.) *Post.*
1978 Walter Kerr, *The New York Times.*
1979 Paul Gapp, *Chicago Tribune.*
1980 William A. Henry III, *The Boston Globe.*
1981 Jonathan Yardley, *The Washington* (D.C.) *Star.*
1982 Martin Bernheimer, *Los Angeles Times.*
1983 Manuela Hoelterhoff, *The Wall Street Journal.*
1984 Paul Goldberger, *The New York Times.*
1985 Howard Rosenberg, *Los Angeles Times.*
1986 Donal Henahan, *The New York Times.*
1987 Richard Eder, *Los Angeles Times.*
1988 Tom Shales, *The Washington* (D.C.) *Post.*
1989 Michael Skube, *The News and Observer* (Raleigh, N.C.).
1990 Allan Temko, *San Francisco Chronicle.*
1991 David Shaw, *Los Angeles Times.*
1992 No award.
1993 Michael Dirda, *The Washington* (D.C.) *Post.*
1994 Lloyd Schwartz, *The Boston Phoenix.*
1995 Margo Jefferson, *The New York Times.*
1996 Robert Campbell, *The Boston Globe.*
1997 Tim Page, *The Washington* (D.C.) *Post.*
1998 Michiko Kakutani, *The New York Times.*
1999 Blair Kamin, *Chicago Tribune.*
2000 Henry Allen, *The Washington* (D.C.) *Post.*
2001 Gail Caldwell, *The Boston Globe.*
2002 Justin Davidson, *Newsday* (Melville, N.Y.)

Commentary

1970 Marquis Childs, *St. Louis Post-Dispatch.*
1971 William A. Caldwell, *The Record* (Hackensack, N.J.).
1972 Mike Royko, *Chicago Daily News.*
1973 David S. Broder, *The Washington* (D.C.) *Post.*
1974 Edwin A. Roberts, Jr., *The National Observer.*
1975 Mary McGrory, *Star-News* (Washington, D.C.).
1976 Red Smith, *The New York Times.*
1977 George F. Will, Washington Post Writers Group.
1978 William Safire, *The New York Times.*
1979 Russell Baker, *The New York Times.*
1980 Ellen H. Goodman, *The Boston Globe.*
1981 Dave Anderson, *The New York Times.*
1982 *Art Buchwald, Los Angeles Times Syndicate.
1983 Claude Sitton, *The News and Observer* (Raleigh, N.C.).
1984 Vermont C. Royster, *The Wall Street Journal.*
1985 Murray Kempton, *Newsday* (Melville, N.Y.)
1986 Jimmy Breslin, *Daily News* (New York).
1987 Charles Krauthammer, Washington Post Writers Group.
1988 Dave Barry, *The Miami Herald.*
1989 Clarence Page, *Chicago Tribune.*
1990 Jim Murray, *Los Angeles Times.*
1991 Jim Hoagland, *The Washington* (D.C.) *Post.*
1992 Anna Quindlen, *The New York Times.*
1993 Liz Balmaseda, *The Miami Herald.*
1994 William Raspberry, *The Washington* (D.C.) *Post.*
1995 Jim Dwyer, *Newsday* (Melville, N.Y.).
1996 E. R. Shipp, *Daily News* (New York).
1997 Eileen McNamara, *The Boston Globe.*
1998 Mike McAlary, *New York Daily News.*
1999 Maureen Dowd, *The New York Times.*
2000 Paul A. Gigot, *The Wall Street Journal.*
2001 Dorothy Rabinowitz, *The Wall Street Journal.*
2002 Thomas Friedman, *The New York Times.*

Cartoon

1922 Rollin Kirby, *The World* (New York).
1923 No award.
1924 *Ding Darling, *The Register & Tribune* (Des Moines, Iowa).
1925 Rollin Kirby, *The World* (New York).
1926 D. R. Fitzpatrick, *St. Louis Post-Dispatch.*
1927 Nelson Harding, *Brooklyn Daily Eagle.*
1928 Nelson Harding, *Brooklyn Daily Eagle.*
1929 Rollin Kirby, *The World* (New York).
1930 Charles R. Macauley, *Brooklyn Daily Eagle.*
1931 Edmund Duffy, *The Sun* (Baltimore).
1932 John T. McCutcheon, *Chicago Tribune.*
1933 Harold M. Talburt, *Washington* (D.C.) *Daily News.*
1934 Edmund Duffy, *The Sun* (Baltimore).
1935 Ross A. Lewis, *The Milwaukee Journal.*
1936 No award.
1937 Clarence D. Batchelor, *Daily News* (New York).
1938 Vaughn Shoemaker, *Chicago Daily News.*
1939 Charles G. Werner, *The Daily Oklahoman* (Oklahoma City).
1940 Edmund Duffy, *The Sun* (Baltimore).
1941 Jacob Burck, *The Times* (Chicago).
1942 *Herbert L. Block, Newspaper Enterprise Association.
1943 *Ding Darling, *The Register & Tribune* (Des Moines, Iowa).
1944 Clifford K. Berryman, *The Washington* (D.C.) *Evening Star.*
1945 *Bill Mauldin, United Feature Syndicate, Inc.
1946 Bruce A. Russell, *Los Angeles Times.*
1947 Vaughn Shoemaker, *Chicago Daily News.*
1948 Rube Goldberg, *The Sun* (New York).
1949 Lute Pease, *Newark* (N.J.) *Evening News.*
1950 James T. Berryman, *The Washington* (D.C.) *Evening Star.*
1951 Reginald W. Manning, *The Arizona Republic* (Phoenix).
1952 Fred L. Packer, *New York Mirror.*
1953 Edward D. Kuekes, *The Plain Dealer* (Cleveland).
1954 *Herbert L. Block, *The Washington* (D.C.) *Post.*
1955 Daniel R. Fitzpatrick, *St. Louis Post-Dispatch.*
1956 Robert York, *Louisville* (Ky.) *Times.*
1957 Tom Little, *The* (Nashville) *Tennessean.*
1958 Bruce M. Shanks, *Buffalo* (N.Y.) *Evening News.*
1959 *Bill Mauldin, *St. Louis Post-Dispatch.*
1960 No award.
1961 Carey Orr, *Chicago Tribune.*
1962 Edmund S. Valtman, *The Hartford* (Conn.) *Times.*
1963 Frank Miller, *The Des Moines* (Iowa) *Register.*
1964 Paul Conrad, *The Denver Post.*
1965 No award.
1966 Don Wright, *Miami News.*
1967 *Patrick B. Oliphant, *The Denver Post.*
1968 Eugene G. Payne, *The Charlotte* (N.C.) *Observer.*
1969 John Fischetti, *Chicago Daily News.*
1970 Thomas F. Darcy, *Newsday* (Garden City, N.Y.).
1971 Paul Conrad, *Los Angeles Times.*
1972 Jeffrey K. MacNelly, *The Richmond* (Va.) *News Leader.*
1973 No award.
1974 Paul Szep, *The Boston Globe.*
1975 *Garry Trudeau, Universal Press Syndicate.
1976 Tony Auth, *The Philadelphia Inquirer.*
1977 Paul Szep, *The Boston Globe.*
1978 Jeffrey K. MacNelly, *The Richmond* (Va.) *News Leader.*
1979 *Herbert L. Block, *The Washington* (D.C.) *Post.*
1980 Don Wright, *Miami News.*
1981 Mike Peters, *Dayton* (Ohio) *Daily News.*
1982 Ben Sargent, *Austin* (Tex.) *American-Statesman.*
1983 Richard Locher, *Chicago Tribune.*
1984 Paul Conrad, *Los Angeles Times.*
1985 Jeffrey K. MacNelly, *Chicago Tribune.*
1986 Jules Feiffer, *Village Voice* (New York).
1987 Berke Breathed, Washington Post Writers Group.
1988 Doug Marlette, *The Constitution* (Atlanta, Ga.) and *The Charlotte* (N.C.) *Observer.*
1989 Jack Higgins, *Chicago Sun-Times.*
1990 Tom Toles, *Buffalo* (N.Y.) *News.*
1991 Jim Borgman, *The Cincinnati Enquirer.*
1992 Signe Wilkinson, *Philadelphia Daily News.*
1993 Stephen R. Benson, *The Arizona Republic* (Phoenix).
1994 Michael P. Ramirez, *The Commercial Appeal* (Memphis, Tenn.).
1995 Mike Luckovich, *The Atlanta* (Ga.) *Constitution.*
1996 Jim Morin, *The Miami* (Fla.) *Herald.*
1997 Walt Handelsman, *The Times-Picayune* (New Orleans).
1998 Stephen P. Breen, *Asbury Park* (New Jersey) *Press.*
1999 David Horsey, *The Seattle Post-Intelligencer.*
2000 Joel Pett, *Lexington* (Kentucky) *Herald-Leader.*
2001 Ann Telnaes, Tribune Media Services.
2002 Clay Bennett, *The Christian Science Monitor.*

News photography

1942 Milton Brooks, *The Detroit News.*
1943 Frank Noel, The Associated Press.
1944 Frank Filan, The Associated Press; Earle L. Bunker, *The World-Herald* (Omaha, Nebr.).
1945 Joe Rosenthal, The Associated Press.
1946 No award.
1947 Arnold Hardy.
1948 Frank Cushing, *Boston Traveler.*
1949 Nathaniel Fein, *New York Herald Tribune.*
1950 Bill Crouch, *Oakland Tribune* (Calif.).
1951 Max Desfor, The Associated Press.
1952 John Robinson, Don Ultang, *The Register & Tribune* (Des Moines, Iowa).
1953 William M. Gallagher, *The Flint* (Mich.) *Journal.*
1954 Mrs. Walter M. Schau.
1955 John L. Gaunt, Jr., *Los Angeles Times.*
1956 *Daily News* (New York).

*Has a biography in *World Book.*

1957 Harry A. Trask, *Boston Traveler.*
1958 William C. Beall, *Washington* (D.C.) *Daily News.*
1959 William Seaman, *The Minneapolis Star.*
1960 Andrew Lopez, United Press International.
1961 Yasushi Nagao, *Mainichi* (Tokyo).
1962 Paul Vathis, The Associated Press.
1963 Hector Rondon, *La República* (Caracas, Venezuela).
1964 Robert H. Jackson, *The Dallas Times Herald.*
1965 Horst Faas, The Associated Press.
1966 Kyoichi Sawada, United Press International.
1967 Jack R. Thornell, The Associated Press.
1968 Award divided into spot news and feature photography.

Spot news photography

1968 Rocco Morabito, *The Jacksonville* (Fla.) *Journal.*
1969 Edward T. Adams, The Associated Press.
1970 Steve Starr, The Associated Press.
1971 John Paul Filo, *Valley Daily News* (Tarentum, Pa.) and *The Daily Dispatch* (New Kensington, Pa.).
1972 Horst Faas and Michel Laurent, The Associated Press.
1973 Huynh Cong Ut, The Associated Press.
1974 Anthony K. Roberts, free-lancer.
1975 Gerald H. Gay, *The Seattle Times.*
1976 Stanley Forman, *The Boston Herald-American.*
1977 Neal Ulevich, The Associated Press; Stanley Forman, *The Boston Herald-American.*
1978 John Blair, free-lancer.
1979 Thomas J. Kelly III, *The* (Pottstown, Pa.) *Mercury.*
1980 Name withheld, United Press International.
1981 Larry Price, *Fort Worth* (Tex.) *Star-Telegram.*
1982 Ron Edmonds, The Associated Press.
1983 Bill Foley, The Associated Press.
1984 Stan Grossfeld, *The Boston Globe.*
1985 The staff of *The Register* (Santa Ana, Calif.).
1986 Michael duCille and Carol Guzy, *The Miami Herald.*
1987 Kim Komenich, *San Francisco Examiner.*
1988 Scott Shaw, *Odessa* (Tex.) *American.*
1989 Ron Olshwanger, free-lancer.
1990 The staff of *The Tribune* (Oakland, Calif.).
1991 Greg Marinovich, The Associated Press.
1992 The staff of The Associated Press.
1993 Ken Geiger and William Snyder, *The Dallas Morning News.*
1994 Paul Watson, *The Toronto Star.*
1995 Carol Guzy, *The Washington* (D.C.) *Post.*
1996 Charles Porter IV, free-lancer.
1997 Annie Wells, *The Press Democrat* (Santa Rosa, Calif.).
1998 Martha Rial, *Pittsburgh Post-Gazette.*
1999 The staff of The Associated Press.
2000 Award became breaking news photography.

Breaking news photography

2000 The staff of the (Denver, Colo.) *Rocky Mountain News.*
2001 Alan Diaz, The Associated Press.
2002 The staff of *The New York Times.*

Feature photography

1968 Toshio Sakai, United Press International.
1969 Moneta Sleet, Jr., *Ebony.*
1970 Dallas Kinney, *The Palm Beach* (Fla.) *Post.*
1971 Jack Dykinga, *Chicago Sun-Times.*
1972 Dave Kennerly, United Press International.
1973 Brian Lanker, *The Topeka* (Kans.) *Capital-Journal.*
1974 Slava Veder, The Associated Press.
1975 Matthew Lewis, *The Washington* (D.C.) *Post.*
1976 The staff of *The Courier-Journal* and *Times* (Louisville, Ky.).
1977 Robin Hood, *Chattanooga* (Tenn.) *News-Free Press.*
1978 J. Ross Baughman, The Associated Press.
1979 The staff of *The Boston Herald-American.*
1980 Erwin H. Hagler, *Dallas Times Herald.*
1981 Taro M. Yamasaki, *Detroit Free Press.*
1982 John H. White, *Chicago Sun-Times.*
1983 James B. Dickman, *Dallas Times Herald.*
1984 Anthony Suau, *The Denver Post.*
1985 Stan Grossfeld, *The Boston Globe;* Larry C. Price, *The Philadelphia Inquirer.*
1986 Tom Gralish, *The Philadelphia Inquirer.*
1987 David Peterson, *The Des Moines* (Iowa) *Register.*
1988 Michael duCille, *The Miami Herald.*
1989 Manny Crisostomo, *Detroit Free Press.*
1990 David C. Turnley, *Detroit Free Press.*
1991 William Snyder, *Dallas Morning News.*
1992 John Kaplan, *The Herald* (Monterey, Calif.) and *Pittsburgh Post-Gazette.*
1993 The staff of The Associated Press.
1994 Kevin Carter, free-lancer for *The New York Times.*
1995 Jean-Marc Bouju, The Associated Press.
1996 Stephanie Welsh, free-lancer.
1997 Alexander Zemlianichenko, The Associated Press.
1998 Clarence Williams, *Los Angeles Times.*
1999 The staff of The Associated Press.
2000 Carol Guzy, Michael S. Williamson, and Lucian Perkins, *The Washington* (D.C.) *Post.*
2001 Matt Rainey, *The Star-Ledger* (Newark, N.J.).
2002 The staff of *The New York Times.*

Pulitzer Prizes in literature and music

Fiction

1917 No award.
1918 Ernest Poole, *His Family.*
1919 *Booth Tarkington, *The Magnificent Ambersons.*
1920 No award.
1921 *Edith Wharton, *The Age of Innocence.*
1922 *Booth Tarkington, *Alice Adams.*
1923 *Willa Cather, *One of Ours.*
1924 Margaret Wilson, *The Able McLaughlins.*
1925 *Edna Ferber, *So Big.*
1926 *Sinclair Lewis, *Arrowsmith* (declined).
1927 *Louis Bromfield, *Early Autumn.*
1928 *Thornton Wilder, *The Bridge of San Luis Rey.*
1929 Julia M. Peterkin, *Scarlet Sister Mary.*
1930 *Oliver La Farge, *Laughing Boy.*
1931 Margaret A. Barnes, *Years of Grace.*
1932 *Pearl S. Buck, *The Good Earth.*
1933 T. S. Stribling, *The Store.*
1934 Caroline Miller, *Lamb in His Bosom.*
1935 Josephine W. Johnson, *Now in November.*
1936 Harold L. Davis, *Honey in the Horn.*
1937 *Margaret Mitchell, *Gone with the Wind.*
1938 *John P. Marquand, *The Late George Apley.*
1939 *Marjorie Kinnan Rawlings, *The Yearling.*
1940 *John Steinbeck, *The Grapes of Wrath.*
1941 No award.
1942 *Ellen Glasgow, *In This Our Life.*
1943 *Upton Sinclair, *Dragon's Teeth.*
1944 Martin Flavin, *Journey in the Dark.*
1945 *John Hersey, *A Bell for Adano.*
1946 No award.
1947 *Robert Penn Warren, *All the King's Men.*
1948 *James A. Michener, *Tales of the South Pacific.*
1949 *James G. Cozzens, *Guard of Honor.*
1950 *A. B. Guthrie, Jr., *The Way West.*
1951 *Conrad Richter, *The Town.*
1952 *Herman Wouk, *The Caine Mutiny.*
1953 *Ernest Hemingway, *The Old Man and the Sea.*
1954 No award.
1955 *William Faulkner, *A Fable.*
1956 MacKinlay Kantor, *Andersonville.*
1957 No award.
1958 *James Agee, *A Death in the Family.*
1959 Robert L. Taylor, *The Travels of Jaimie McPheeters.*
1960 Allen Drury, *Advise and Consent.*
1961 *Harper Lee, *To Kill a Mockingbird.*
1962 Edwin O'Connor, *The Edge of Sadness.*
1963 *William Faulkner, *The Reivers.*
1964 No award.
1965 Shirley Ann Grau, *The Keepers of the House.*
1966 *Katherine Anne Porter, *The Collected Stories of Katherine Anne Porter.*
1967 *Bernard Malamud, *The Fixer.*
1968 *William Styron, *The Confessions of Nat Turner.*
1969 N. Scott Momaday, *House Made of Dawn.*
1970 *Jean Stafford, *The Collected Stories of Jean Stafford.*
1971 No award.
1972 *Wallace Earle Stegner, *Angle of Repose.*
1973 *Eudora Welty, *The Optimist's Daughter.*
1974 No award.
1975 Michael Shaara, *The Killer Angels.*
1976 *Saul Bellow, *Humboldt's Gift.*
1977 No award.
1978 James Alan McPherson, *Elbow Room.*
1979 *John Cheever, *The Stories of John Cheever.*
1980 *Norman Mailer, *The Executioner's Song.*
1981 John Kennedy Toole, *A Confederacy of Dunces.*
1982 *John Updike, *Rabbit Is Rich.*
1983 *Alice Walker, *The Color Purple.*
1984 William Kennedy, *Ironweed.*
1985 Alison Lurie, *Foreign Affairs.*
1986 *Larry McMurtry, *Lonesome Dove.*
1987 Peter Taylor, *A Summons to Memphis.*
1988 *Toni Morrison, *Beloved.*
1989 *Anne Tyler, *Breathing Lessons.*
1990 Oscar Hijuelos, *The Mambo Kings Play Songs of Love.*
1991 *John Updike, *Rabbit at Rest.*
1992 Jane Smiley, *A Thousand Acres.*
1993 Robert Olen Butler, *A Good Scent from a Strange Mountain.*
1994 E. Annie Proulx, *The Shipping News.*
1995 Carol Shields, *The Stone Diaries.*
1996 Richard Ford, *Independence Day.*
1997 Steven Millhauser, *Martin Dressler.*
1998 *Philip Roth, *American Pastoral.*

*Has a biography in *World Book.*

1999 Michael Cunningham, *The Hours.*
2000 Jhumpa Lahiri, *Interpreter of Maladies.*
2001 Michael Chabon, *The Amazing Adventures of Kavalier & Clay.*
2002 Richard Russo, *Empire Falls.*

Drama

1917 No award.
1918 Jesse L. Williams, *Why Marry?*
1919 No award.
1920 *Eugene O'Neill, *Beyond the Horizon.*
1921 *Zona Gale, *Miss Lulu Bett.*
1922 *Eugene O'Neill, *Anna Christie.*
1923 Owen Davis, *Icebound.*
1924 Hatcher Hughes, *Hell-Bent fer Heaven.*
1925 *Sidney Howard, *They Knew What They Wanted.*
1926 *George E. Kelly, *Craig's Wife.*
1927 *Paul Green, *In Abraham's Bosom.*
1928 *Eugene O'Neill, *Strange Interlude.*
1929 *Elmer Rice, *Street Scene.*
1930 *Marc Connelly, *The Green Pastures.*
1931 *Susan Glaspell, *Alison's House.*
1932 *George S. Kaufman, Morrie Ryskind, * Ira Gershwin, *Of Thee I Sing.*
1933 *Maxwell Anderson, *Both Your Houses.*
1934 *Sidney Kingsley, *Men in White.*
1935 Zoë Akins, *The Old Maid.*
1936 *Robert E. Sherwood, *Idiot's Delight.*
1937 *George S. Kaufman, *Moss Hart, *You Can't Take It with You.*
1938 *Thornton Wilder, *Our Town.*
1939 *Robert E. Sherwood, *Abe Lincoln in Illinois.*
1940 *William Saroyan, *The Time of Your Life* (declined).
1941 *Robert E. Sherwood, *There Shall Be No Night.*
1942 No award.
1943 *Thornton Wilder, *The Skin of Our Teeth.*
1944 No award.
1945 Mary Chase, *Harvey.*
1946 *Howard Lindsay, Russel Crouse, *State of the Union.*
1947 No award.
1948 *Tennessee Williams, *A Streetcar Named Desire.*
1949 *Arthur Miller, *Death of a Salesman.*
1950 *Richard Rodgers, *Oscar Hammerstein II, and *Joshua Logan, *South Pacific.*
1951 No award.
1952 Joseph Kramm, *The Shrike.*
1953 *William Inge, *Picnic.*
1954 John Patrick, *The Teahouse of the August Moon.*
1955 *Tennessee Williams, *Cat on a Hot Tin Roof.*
1956 Frances Goodrich, Albert Hackett, *The Diary of Anne Frank.*
1957 *Eugene O'Neill, *Long Day's Journey into Night.*
1958 Ketti Frings, *Look Homeward, Angel.*
1959 *Archibald MacLeish, *J. B.*
1960 George Abbott, Jerry Bock, Sheldon Harnick, and Jerome Weidman, *Fiorello!*
1961 Tad Mosel, *All the Way Home.*
1962 Abe Burrows and *Frank Loesser, *How to Succeed in Business Without Really Trying.*
1963 No award.
1964 No award.
1965 Frank D. Gilroy, *The Subject Was Roses.*
1966 No award.
1967 *Edward Albee, *A Delicate Balance.*
1968 No award.
1969 Howard Sackler, *The Great White Hope.*
1970 Charles Gordone, *No Place to Be Somebody.*
1971 Paul Zindel, *The Effect of Gamma Rays on Man-in-the-Moon Marigolds.*
1972 No award.
1973 Jason Miller, *That Championship Season.*
1974 No award.
1975 *Edward Albee, *Seascape.*
1976 Michael Bennett, James Kirkwood, Nicholas Dante, Marvin Hamlisch, and Edward Kleban, *A Chorus Line.*
1977 Michael Cristofer, *The Shadow Box.*
1978 D. L. Coburn, *The Gin Game.*
1979 *Sam Shepard, *Buried Child.*
1980 *Lanford Wilson, *Talley's Folly.*
1981 Beth Henley, *Crimes of the Heart.*
1982 Charles Fuller, *A Soldier's Play.*
1983 Marsha Norman, *'night, Mother.*
1984 *David Mamet, *Glengarry Glen Ross.*
1985 *Stephen Sondheim and James Lapine, *Sunday in the Park with George.*
1986 No award.
1987 *August Wilson, *Fences.*
1988 Alfred Uhry, *Driving Miss Daisy.*
1989 *Wendy Wasserstein, *The Heidi Chronicles.*
1990 *August Wilson, *The Piano Lesson.*
1991 *Neil Simon, *Lost in Yonkers.*
1992 Robert Schenkkan, *The Kentucky Cycle.*
1993 Tony Kushner, *Angels in America: Millennium Approaches.*
1994 *Edward Albee, *Three Tall Women.*
1995 Horton Foote, *The Young Man from Atlanta.*
1996 Jonathan Larson, *Rent.*
1997 No award
1998 Paula Vogel, *How I Learned to Drive.*
1999 Margaret Edson, *Wit.*
2000 Donald Margulies, *Dinner with Friends.*
2001 David Auburn, *Proof.*
2002 Suzan-Lori Parks, *Topdog/Underdog.*

History

1917 J. J. Jusserand, *With Americans of Past and Present Days.*
1918 James Rhodes, *A History of the Civil War, 1861-1865.*
1919 No award.
1920 Justin H. Smith, *The War with Mexico.*
1921 William S. Sims, *The Victory at Sea.*
1922 James T. Adams, *The Founding of New England.*
1923 Charles Warren, *The Supreme Court in United States History.*
1924 Charles H. McIlwain, *The American Revolution—A Constitutional Interpretation.*
1925 Frederic Paxson, *A History of the American Frontier.*
1926 Edward Channing, *The War for Southern Independence,* volume 6 of *The History of the United States.*
1927 Samuel F. Bemis, *Pinckney's Treaty.*
1928 Vernon L. Parrington, *Main Currents in American Thought.*
1929 Fred A. Shannon, *The Organization and Administration of the Union Army,* 1861-1865.
1930 Claude H. Van Tyne, *The War of Independence.*
1931 Bernadotte E. Schmitt, *The Coming of the War: 1914.*
1932 *John J. Pershing, *My Experiences in the World War.*
1933 *Frederick J. Turner, *The Significance of Sections in American History.*
1934 Herbert Agar, *The People's Choice.*
1935 Charles M. Andrews, *The Colonial Period of American History.*
1936 Andrew C. McLaughlin, *The Constitutional History of the United States.*
1937 *Van Wyck Brooks, *The Flowering of New England.*
1938 Paul H. Buck, *The Road to Reunion, 1865-1900.*
1939 Frank L. Mott, *A History of American Magazines.*
1940 *Carl Sandburg, *Abraham Lincoln: The War Years.*
1941 Marcus Hansen, *The Atlantic Migration, 1607-1860.*
1942 Margaret Leech, *Reveille in Washington.*
1943 *Esther Forbes, *Paul Revere and the World He Lived In.*
1944 Merle Curti, *The Growth of American Thought.*
1945 Stephen Bonsal, *Unfinished Business.*
1946 *Arthur M. Schlesinger, Jr., *The Age of Jackson.*
1947 James P. Baxter III, *Scientists Against Time.*
1948 *Bernard De Voto, *Across the Wide Missouri.*
1949 Roy F. Nichols, *The Disruption of American Democracy.*
1950 Oliver W. Larkin, *Art and Life in America.*
1951 R. Carlyle Buley, *The Old Northwest, Pioneer Period 1815-1840.*
1952 Oscar Handlin, *The Uprooted.*
1953 George Dangerfield, *The Era of Good Feelings.*
1954 *Bruce Catton, *A Stillness at Appomattox.*
1955 Paul Horgan, *Great River: The Rio Grande in North American History.*
1956 Richard Hofstadter, *The Age of Reform.*
1957 *George F. Kennan, *Russia Leaves the War: Soviet-American Relations, 1917-1920.*
1958 Bray Hammond, *Banks and Politics in America: From the Revolution to the Civil War.*
1959 Leonard D. White and Jean Schneider, *The Republican Era: 1869-1901.*
1960 Margaret Leech, *In the Days of McKinley.*
1961 Herbert Feis, *Between War and Peace: The Potsdam Conference.*
1962 Lawrence Henry Gipson, *The Triumphant Empire: Thunder-Clouds Gather in the West, 1763-1766.*
1963 Constance McLaughlin Green, *Washington, Village and Capital, 1800-1878.*
1964 Sumner Chilton Powell, *Puritan Village: The Formation of a New England Town.*
1965 Irwin Unger, *The Greenback Era.*
1966 Perry Miller, *The Life of the Mind in America: From the Revolution to the Civil War.*
1967 William H. Goetzmann, *Exploration and Empire.*
1968 Bernard Bailyn, *The Ideological Origins of the American Revolution.*
1969 Leonard W. Levy, *Origins of the Fifth Amendment.*
1970 *Dean Gooderham Acheson, *Present at the Creation: My Years in the State Department.*
1971 James MacGregor Burns, *Roosevelt: The Soldier of Freedom.*
1972 Carl N. Degler, *Neither Black Nor White: Slavery and Race Relations in Brazil and the United States.*
1973 Michael Kammen, *People of Paradox: An Inquiry Concerning the Origins of American Civilization.*
1974 Daniel J. Boorstin, *The Americans: The Democratic Experience.*
1975 Dumas Malone, volumes 1 through 5 of *Jefferson and His Time.*
1976 Paul Horgan, *Lamy of Santa Fe.*
1977 David M. Potter, *The Impending Crisis.*
1978 Alfred D. Chandler, Jr., *The Invisible Hand: The Managerial Revolution in American Business.*
1979 Don E. Fehrenbacher, *The Dred Scott Case: Its Significance in Ameri can Law and Politics.*
1980 Leon F. Litwack, *Been in the Storm So Long: The Aftermath of Slavery.*
1981 Lawrence A. Cremin, *American Education: The National Experience, 1783-1876.*
1982 C. Vann Woodward, ed. *Mary Chesnut's Civil War.*
1983 Rhys L. Isaac, *The Transformation of Virginia, 1740-1790.*

*Has a biography in *World Book.*

1984 No award.
1985 Thomas K. McCraw, *The Prophets of Regulation.*
1986 Walter A. McDougall, *... the Heavens and the Earth: A Political History of the Space Age.*
1987 Bernard Bailyn, *Voyagers to the West: A Passage in the Peopling of America on the Eve of the Revolution.*
1988 Robert V. Bruce, *The Launching of Modern American Science, 1846-1876.*
1989 Taylor Branch, *Parting the Waters: America in the King Years, 1954-1963;* James M. McPherson, *Battle Cry of Freedom: The Civil War Era.*
1990 Stanley Karnow, *In Our Image: America's Empire in the Philippines.*
1991 Laurel Thatcher Ulrich, *A Midwife's Tale: The Life of Martha Ballard, Based on Her Diary, 1785-1812.*
1992 Mark E. Neeley, Jr., *The Fate of Liberty: Abraham Lincoln and Civil Liberties.*
1993 Gordon S. Wood, *The Radicalism of the American Revolution.*
1994 No award.
1995 Doris Kearns Goodwin, *No Ordinary Time: Franklin and Eleanor Roosevelt: The Home Front in World War II.*
1996 Alan Taylor, *William Cooper's Town: Power and Persuasion on the Frontier of the Early American Republic.*
1997 Jack N. Rakove, *Original Meanings: Politics and Ideas in the Making of the Constitution.*
1998 Edward J. Larson, *Summer for the Gods: The Scopes Trial and America's Continuing Debate over Science and Religion.*
1999 Edwin G. Burrows and Mike Wallace, *Gotham: A History of New York City to 1898.*
2000 David M. Kennedy, *Freedom from Fear: The American People in Depression and War, 1929-1945.*
2001 Joseph J. Ellis, *Founding Brothers: The Revolutionary Generation.*
2002 Louis Menand, *The Metaphysical Club: A Story of Ideas in America.*

Biography or autobiography

1917 *Laura E. H. Richards, Maude H. Elliott, Florence H. Hall, *Julia Ward Howe.*
1918 William C. Bruce, *Benjamin Franklin, Self-Revealed.*
1919 *Henry Adams, *The Education of Henry Adams.*
1920 Albert J. Beveridge, *The Life of John Marshall.*
1921 Edward W. Bok, *The Americanization of Edward Bok.*
1922 *Hamlin Garland, *A Daughter of the Middle Border.*
1923 Burton J. Hendrick, *The Life and Letters of Walter H. Page.*
1924 *Michael I. Pupin, *From Immigrant to Inventor.*
1925 M. A. DeWolfe Howe, *Barrett Wendell and His Letters.*
1926 *Harvey Cushing, *The Life of Sir William Osler.*
1927 Emory Holloway, *Whitman.*
1928 Charles E. Russell, *The American Orchestra and Theodore Thomas.*
1929 Burton J. Hendrick, *The Training of an American: The Earlier Life and Letters of Walter H. Page.*
1930 Marquis James, *The Raven.*
1931 Henry James, *Charles W. Eliot.*
1932 Henry F. Pringle, *Theodore Roosevelt.*
1933 *Allan Nevins, *Grover Cleveland.*
1934 Tyler Dennett, *John Hay.*
1935 *Douglas Southall Freeman, *R. E. Lee.*
1936 Ralph B. Perry, *The Thought and Character of William James.*
1937 *Allan Nevins, *Hamilton Fish.*
1938 Odell Shepard, *Pedlar's Progress;* Marquis James, *Andrew Jackson.*
1939 *Carl Van Doren, *Benjamin Franklin.*
1940 Ray S. Baker, *Woodrow Wilson, Life and Letters.*
1941 Ola E. Winslow, *Jonathan Edwards.*
1942 Forrest Wilson, *Crusader in Crinoline.*
1943 *Samuel E. Morison, *Admiral of the Ocean Sea.*
1944 Carlton Mabee, *The American Leonardo: The Life of Samuel F. B. Morse.*
1945 Russell B. Nye, *George Bancroft: Brahmin Rebel.*
1946 Linnie M. Wolfe, *Son of the Wilderness.*
1947 *William Allen White, *The Autobiography of William Allen White.*
1948 Margaret Clapp, *Forgotten First Citizen: John Bigelow.*
1949 *Robert E. Sherwood, *Roosevelt and Hopkins.*
1950 Samuel F. Bemis, *John Quincy Adams and the Foundations of American Foreign Policy.*
1951 Margaret L. Coit, *John C. Calhoun: American Portrait.*
1952 Merlo J. Pusey, *Charles Evans Hughes.*
1953 David J. Mays, *Edmund Pendleton, 1721-1803.*
1954 *Charles A. Lindbergh, *The Spirit of St. Louis.*
1955 William S. White, *The Taft Story.*
1956 Talbot F. Hamlin, *Benjamin Henry Latrobe.*
1957 *John F. Kennedy, *Profiles in Courage.*
1958 *Douglas Southall Freeman, Mary W. Ashworth, John A. Carroll, *George Washington.*
1959 Arthur Walworth, *Woodrow Wilson, American Prophet.*
1960 *Samuel E. Morison, *John Paul Jones.*
1961 David Herbert Donald, *Charles Sumner and the Coming of the Civil War.*
1962 No award.
1963 Leon Edel, *The Conquest of London and The Middle Years,* volumes II and III of *Henry James.*
1964 W. Jackson Bate, *John Keats.*
1965 Ernest Samuels, *Henry Adams.*
1966 *Arthur M. Schlesinger, Jr., *A Thousand Days.*
1967 Justin Kaplan, *Mr. Clemens and Mark Twain.*
1968 *George F. Kennan, *Memoirs (1925-1950).*
1969 Benjamin Lawrence Reid, *The Man from New York: John Quinn and His Friends.*
1970 T. Harry Williams, *Huey Long.*
1971 Lawrance R. Thompson, *Robert Frost: The Years of Triumph, 1915-1938.*
1972 Joseph P. Lash, *Eleanor and Franklin: The Story of Their Relationship Based on Eleanor Roosevelt's Private Papers.*
1973 W. A. Swanberg, *Luce and His Empire.*
1974 Louis Sheaffer, *O'Neill, Son and Artist.*
1975 Robert A. Caro, *The Power Broker: Robert Moses and the Fall of New York.*
1976 R. W. B. Lewis, *Edith Wharton: A Biography.*
1977 John E. Mack, *A Prince of Our Disorder: The Life of T. E. Lawrence.*
1978 W. Jackson Bate, *Samuel Johnson.*
1979 Leonard Baker, *Days of Sorrow and Pain: Leo Baeck and the Berlin Jews.*
1980 Edmund Morris, *The Rise of Theodore Roosevelt.*
1981 Robert K. Massie, *Peter the Great: His Life and World.*
1982 William S. McFeely, *Grant: A Biography.*
1983 Russell Baker, *Growing Up.*
1984 Louis R. Harlan, *Booker T. Washington: The Wizard of Tuskegee, 1901-1915.*
1985 Kenneth Silverman, *The Life and Times of Cotton Mather.*
1986 Elizabeth Frank, *Louise Bogan: A Portrait.*
1987 David J. Garrow, *Bearing the Cross: Martin Luther King, Jr., and the Southern Christian Leadership Conference.*
1988 David Herbert Donald, *Look Homeward: A Life of Thomas Wolfe.*
1989 Richard Ellmann, *Oscar Wilde.*
1990 Sebastian de Grazia, *Machiavelli in Hell.*
1991 Steven Naifeh and Gregory White Smith, *Jackson Pollock: An American Saga.*
1992 Lewis B. Puller, Jr., *Fortunate Son: The Healing of a Vietnam Vet.*
1993 David McCullough, *Truman.*
1994 David Levering Lewis, *W. E. B. Du Bois: Biography of a Race, 1868-1919.*
1995 Joan D. Hedrick, *Harriet Beecher Stowe: A Life.*
1996 Jack Miles, *God: A Biography.*
1997 Frank McCourt, *Angela's Ashes: A Memoir.*
1998 *Katharine Graham, *Personal History.*
1999 A. Scott Berg, *Lindbergh.*
2000 Stacy Schiff, *Véra (Mrs. Vladimir Nabokov).*
2001 David Levering Lewis, *W. E. B. Du Bois: The Fight for Equality and The American Century, 1919-1963.*
2002 David McCullough, *John Adams.*

Poetry

The Pulitzer Prize for poetry was established in 1922, but earlier awards were made through gifts provided by the Poetry Society. The awards made in 1918 and 1919 are carried in the Pulitzer Prize records.

1918 *Sara Teasdale, *Love Songs.*
1919 Margaret Widdemer, *Old Road to Paradise.* *Carl Sandburg, *Corn Huskers.*
1920 No award.
1921 No award.
1922 *Edwin Arlington Robinson, *Collected Poems.*
1923 *Edna St. Vincent Millay, *The Ballad of the Harp-Weaver; A Few Figs from Thistles;* eight sonnets in *American Poetry, 1922: A Miscellany.*
1924 *Robert Frost, *New Hampshire: A Poem with Notes and Grace Notes.*
1925 *Edwin Arlington Robinson, *The Man Who Died Twice.*
1926 *Amy Lowell, *What's O'Clock.*
1927 Leonora Speyer, *Fiddler's Farewell.*
1928 *Edwin Arlington Robinson, *Tristram.*
1929 *Stephen Vincent Benét, *John Brown's Body.*
1930 *Conrad Aiken, *Selected Poems.*
1931 *Robert Frost, *Collected Poems.*
1932 George Dillon, *The Flowering Stone.*
1933 *Archibald MacLeish, *Conquistador.*
1934 *Robert Hillyer, *Collected Verse.*
1935 Audrey Wurdemann, *Bright Ambush.*
1936 *Robert P. Tristram Coffin, *Strange Holiness.*
1937 *Robert Frost, *A Further Range.*
1938 Marya Zaturenska, *Cold Morning Sky.*
1939 John Gould Fletcher, *Selected Poems.*
1940 *Mark Van Doren, *Collected Poems.*
1941 Leonard Bacon, *Sunderland Capture.*
1942 *William Rose Benét, *The Dust Which Is God.*
1943 *Robert Frost, *A Witness Tree.*
1944 *Stephen Vincent Benét, *Western Star.*
1945 *Karl Shapiro, *V-Letter and Other Poems.*
1946 No award.
1947 *Robert Lowell, *Lord Weary's Castle.*
1948 *W. H. Auden, *The Age of Anxiety.*
1949 Peter Viereck, *Terror and Decorum.*
1950 *Gwendolyn Brooks, *Annie Allen.*
1951 *Carl Sandburg, *Complete Poems.*
1952 *Marianne Moore, *Collected Poems.*
1953 *Archibald MacLeish, *Collected Poems 1917-1952.*
1954 *Theodore Roethke, *The Waking: Poems 1933-1953.*
1955 *Wallace Stevens, *Collected Poems.*

*Has a biography in *World Book.*

1956 *Elizabeth Bishop, *Poems: North & South—A Cold Spring.*
1957 *Richard Wilbur, *Things of This World.*
1958 *Robert Penn Warren, *Promises: Poems 1954-1956.*
1959 Stanley Kunitz, *Selected Poems, 1928-1958.*
1960 William DeWitt Snodgrass, *Heart's Needle.*
1961 *Phyllis McGinley, *Times Three: Selected Verse from Three Decades.*
1962 Alan Dugan, *Poems.*
1963 *William Carlos Williams, *Pictures from Brueghel.*
1964 Louis Simpson, *At the End of the Open Road.*
1965 *John Berryman, *Seventy-Seven Dream Songs.*
1966 *Richard Eberhart, *Selected Poems (1930-1965).*
1967 *Anne Sexton, *Live or Die.*
1968 Anthony Hecht, *The Hard Hours.*
1969 George Oppen, *Of Being Numerous.*
1970 Richard Howard, *Untitled Subjects.*
1971 *W. S. Merwin, *The Carrier of Ladders.*
1972 James Wright, *Collected Poems.*
1973 Maxine Winokur Kumin, *Up Country.*
1974 *Robert Lowell, *The Dolphin.*
1975 Gary Snyder, *Turtle Island.*
1976 *John Ashbery, *Self-Portrait in a Convex Mirror.*
1977 *James Merrill, *Divine Comedies.*
1978 Howard Nemerov, *Collected Poems.*
1979 *Robert Penn Warren, *Now and Then: Poems 1976-1978.*
1980 Donald Justice, *Selected Poems.*
1981 James Schuyler, *The Morning of the Poem.*
1982 *Sylvia Plath, *The Collected Poems.*
1983 Galway Kinnell, *Selected Poems.*
1984 Mary Oliver, *American Primitive.*
1985 Carolyn Kizer, *Yin.*
1986 Henry Taylor, *The Flying Change.*
1987 *Rita Dove, *Thomas and Beulah.*
1988 William Meredith, *Partial Accounts: New and Selected Poems.*
1989 *Richard Wilbur, *New and Collected Poems.*
1990 Charles Simic, *The World Doesn't End.*
1991 Mona Van Duyn, *Near Changes.*
1992 James Tate, *Selected Poems.*
1993 Louise Gluck, *The Wild Iris.*
1994 Yusef Komunyakaa, *Neon Vernacular.*
1995 Philip Levine, *The Simple Truth.*
1996 Jorie Graham, *The Dream of the Unified Field.*
1997 Lisel Mueller, *Alive Together: New and Selected Poems.*
1998 Charles Wright, *Black Zodiac.*
1999 Mark Strand, *Blizzard of One.*
2000 C. K. Williams, *Repair.*
2001 Stephen Dunn, *Different Hours.*
2002 Carl Dennis, *Practical Gods.*

General nonfiction

1962 Theodore H. White, *The Making of the President,* 1960.
1963 *Barbara W. Tuchman, *The Guns of August.*
1964 Richard Hofstadter, *Anti-Intellectualism in American Life.*
1965 Howard Mumford Jones, *O Strange New World.*
1966 Edwin Way Teale, *Wandering Through Winter.*
1967 David Brion Davis, *The Problem of Slavery in Western Culture.*
1968 *Will and Ariel Durant, *Rousseau and Revolution.*
1969 *Norman Mailer, *The Armies of the Night.* *René Jules Dubos, *So Human an Animal: How We Are Shaped by Surroundings and Events.*
1970 *Erik H. Erikson, *Gandhi's Truth: On the Origins of Militant Nonviolence.*
1971 John Toland, *The Rising Sun.*
1972 *Barbara W. Tuchman, *Stilwell and the American Experience in China, 1911-1945.*
1973 Frances FitzGerald, *Fire in the Lake: The Vietnamese and the Americans in Vietnam.* Robert M. Coles, volumes two and three of *Children of Crisis.*
1974 Ernest Becker, *The Denial of Death.*
1975 Annie Dillard, *Pilgrim at Tinker Creek.*
1976 Robert N. Butler, *Why Survive? Being Old in America.*
1977 William W. Warner, *Beautiful Swimmers: Watermen, Crabs and the Chesapeake Bay.*
1978 *Carl Sagan, *The Dragons of Eden: Speculations on the Evolution of Human Intelligence.*
1979 Edward O. Wilson, *On Human Nature.*
1980 Douglas R. Hofstadter, *Gödel, Escher, Bach: An Eternal Golden Braid.*
1981 Carl E. Schorske, *Fin-de-Siècle Vienna: Politics and Culture.*
1982 Tracy Kidder, *The Soul of a New Machine.*
1983 Susan Sheehan, *Is There No Place on Earth for Me?*
1984 Paul Starr, *The Social Transformation of American Medicine.*
1985 Studs Terkel, *"The Good War": An Oral History of World War Two.*
1986 Joseph Lelyveld, *Move Your Shadow: South Africa, Black and White.* J. Anthony Lukas, *Common Ground: A Turbulent Decade in the Lives of Three American Families.*
1987 David K. Shipler, *Arab and Jew: Wounded Spirits in a Promised Land.*
1988 Richard Rhodes, *The Making of the Atomic Bomb.*
1989 Neil Sheehan, *A Bright Shining Lie: John Paul Vann and America in Vietnam.*
1990 Dale Maharidge and Michael Williamson, *And Their Children After Them.*
1991 Bert Hölldobler and Edward O. Wilson, *The Ants.*
1992 Daniel Yergin, *The Prize: The Epic Quest for Oil, Money and Power.*
1993 Garry Wills, *Lincoln at Gettysburg: The Words That Remade America.*
1994 David Remnick, *Lenin's Tomb: The Last Days of the Soviet Empire.*
1995 Jonathan Weiner, *The Beak of the Finch: A Story of Evolution in Our Time.*
1996 Tina Rosenberg, *The Haunted Land: Facing Europe's Ghosts After Communism.*
1997 Richard Kluger, *Ashes to Ashes: America's Hundred-Year Cigarette War, the Public Health, and the Unabashed Triumph of Philip Morris.*
1998 Jared Diamond, *Guns, Germs, and Steel: The Fates of Human Societies.*
1999 John McPhee, *Annals of the Former World.*
2000 John W. Dower, *Embracing Defeat: Japan in the Wake of World War II.*
2001 Hubert P. Bix, *Hirohito and the Making of Modern Japan.*
2002 Diane McWhorter, *Carry Me Home: Birmingham, Alabama, the Climactic Battle of the Civil Rights Revolution.*

Music

1943 *William Schuman, Secular Cantata No. 2.
1944 *Howard Hanson, Symphony No. 4, opus 34.
1945 *Aaron Copland, *Appalachian Spring.*
1946 Leo Sowerby, *The Canticle of the Sun.*
1947 *Charles Ives, Symphony No. 3.
1948 *Walter Piston, Symphony No. 3.
1949 *Virgil Thomson, *Louisiana Story.*
1950 *Gian Carlo Menotti, *The Consul.*
1951 *Douglas Moore, *Giants in the Earth.*
1952 Gail Kubik, *Symphony Concertante.*
1953 No award.
1954 Quincy Porter, Concerto for Two Pianos and Orchestra.
1955 *Gian Carlo Menotti, *The Saint of Bleecker Street.*
1956 Ernst Toch, Symphony No. 3.
1957 *Norman Dello Joio, *Meditations on Ecclesiastes.*
1958 *Samuel Barber, *Vanessa.*
1959 John La Montaine, Concerto for Piano and Orchestra.
1960 *Elliott Carter, String Quartet No. 2.
1961 *Walter Piston, Symphony No. 7.
1962 Robert Ward, *The Crucible.*
1963 *Samuel Barber, Piano Concerto No. 1.
1964 No award.
1965 No award.
1966 Leslie Bassett, Variations for Orchestra.
1967 Leon Kirchner, String Quartet No. 3.
1968 *George Crumb, *Echoes of Time and the River.*
1969 Karel Husa, String Quartet No. 3.
1970 Charles W. Wuorinen, *Time's Encomium.*
1971 Mario Davidovsky, *Synchronisms No. 6.*
1972 Jacob Druckman, *Windows.*
1973 *Elliott Carter, String Quartet No. 3.
1974 Donald Martino, *Notturno.*
1975 Dominick Argento, *From the Diary of Virginia Woolf.*
1976 Ned Rorem, *Air Music.*
1977 Richard Wernick, *Visions of Terror and Wonder.*
1978 Michael Colgrass, *Déjà Vu for Percussion Quartet and Orchestra.*
1979 Joseph Schwantner, *Aftertones of Infinity.*
1980 David Del Tredici, *In Memory of a Summer Day.*
1981 No award.
1982 *Roger Sessions, Concerto for Orchestra.
1983 *Ellen Taafe Zwilich, Symphony No. 1, Three Movements for Orchestra.
1984 Bernard Rands, *Canti del Sole.*
1985 Stephen Albert, *Symphony, RiverRun.*
1986 George Perle, Wind Quintet No. 4.
1987 John Harbison, *The Flight into Egypt.*
1988 William Bolcom, *12 New Etudes for Piano.*
1989 Roger Reynolds, *Whispers Out of Time.*
1990 Mel Powell, *Duplicates.*
1991 Shulamit Ran, Symphony.
1992 Wayne Peterson, *The Face of the Night, the Heart of the Dark.*
1993 Christopher Rouse, Trombone Concerto.
1994 Gunther Schuller, *Of Reminiscences and Reflections.*
1995 *Morton Gould, *Stringmusic.*
1996 George Walker, *Lilacs.*
1997 *Wynton Marsalis, *Blood on the Fields.*
1998 Aaron Jay Kernis, String Quartet No. 2 *(Musica Instrumentalis).*
1999 Melinda Wagner, *Concerto for Flute, Strings and Percussion.*
2000 Lewis Spratlan, *Life Is a Dream, Opera in Three Acts: Act II, Concert Version.*
2001 John Corigliano, *Symphony No. 2 for String Orchestra.*
2002 Henry Brant, *Ice Field.*

Special citations

1930 William O. Dapping, *The Auburn* (N.Y.) *Citizen,* for his reporting on the outbreak at Auburn prison in December 1929.
1938 *Edmonton* (Alta.) *Journal,* for its defense of the freedom of the press in Alberta.
1941 *The New York Times,* for the public educational value of its foreign news reports.
1944 Byron Price, U.S. Office of Censorship director, for creating and administering newspaper and radio codes during World War II.

*Has a biography in *World Book.*

1944		Mrs. William Allen White, for her husband's services on the Advisory Board on Pulitzer Prizes.
1944	*	Richard Rodgers and *Oscar Hammerstein II, for their musical play *Oklahoma!*
1945		The cartographers of the American press, for their war maps that helped increase public information on the progress of the armed forces in World War II.
1947		Columbia University and its Graduate School of Journalism, for efforts to maintain and advance the high standards governing the Pulitzer Prizes.
1947		*St. Louis Post-Dispatch,* for unswerving adherence to the ideals of its founder and its constructive leadership in American journalism.
1948		Frank D. Fackenthal, Provost of Columbia University, for his interest in and service to the advisory board.
1951		Cyrus L. Sulzberger, *The New York Times,* for his exclusive interview with Archbishop Alojzije Stepinac.
1952		Max Rae, *New York Journal-American,* for his exclusive exposure of bribery in basketball.
1952		*The Kansas City* (Mo.) *Star,* for its news coverage of the 1951 flood in Kansas and Missouri.
1953		*The New York Times,* for its Sunday "Review of the Week" section.
1957		Kenneth Roberts, for his historical novels that have helped create greater interest in early American history.
1958	*	Walter Lippmann, syndicated columnist, for the wisdom and sense of responsibility in his columns on national and foreign affairs.
1960		Garrett Mattingly, for his book *The Armada.*
1961		*American Heritage Picture History of the Civil War.*
1964		Gannett newspaper group, for its series *The Road to Integration.*
1973		James Thomas Flexner, for his biography *George Washington.*
1974	*	Roger Sessions, for his life's work as a distinguished composer.
1976	*	Scott Joplin, for his contribution to American music; John Hohenberg, for services for 22 years as administrator of the Pulitzer Prizes and for achievements as teacher and journalist.
1977	*	Alex Haley, for his book *Roots.*
1978	*	E. B. White, for the full body of his works; Richard L. Strout, for many years of journalistic dedication.
1982		Milton Babbitt, for his life's work as a distinguished and seminal American composer.
1984	*	Theodor Seuss Geisel, who wrote under the pen name *Dr. Seuss, for his children's books.
1985	*	William Schuman, for more than half a century of contribution to American music as a composer and an educational leader.
1987		Joseph Pulitzer, Jr., for his 31 years as chairman of the Pulitzer Prize Board.
1992		Art Spiegelman, for his book *Maus.*
1996		Herb Caen, *San Francisco Chronicle,* for his extraordinary and continuing contribution as a voice and conscience of his city.
1998	*	George Gershwin, composer, on the 100th anniversary of his birth.
1999	*	Duke Ellington, composer and bandleader, on the 100th anniversary of his birth.

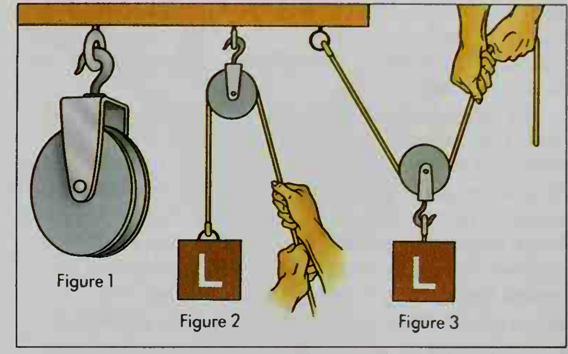
*Has a biography in *World Book.*

Pulley is a wheel over which a rope or belt is passed for the purpose of transmitting energy and doing work. The rim of the pulley is grooved when the pulley carries either a rope or a belt that has a V-shaped cross section. However, if the pulley is to carry a belt that has a flat cross section, the rim of the pulley is barrel-shaped. The flat belt rides on the highest part of the rim.

The simplest pulley is a grooved wheel on a fixed axle. A rope passing over this wheel is tied to the load to be lifted, and a pull is applied to the other end of the rope. This type of pulley gives no mechanical advantage of lift, but it changes the direction of the force applied to the load. This is important when the space directly under the load is hard to get at, as when the load is in a boat.

When the pulley is to carry a continuous turning motion, the two ends of the rope are laced together. A belt used in this way is usually manufactured as an unbroken circular unit. A second pulley, which is connected to the source of energy, transmits a steady rotation to the first pulley. If the driver pulley and the driven pulley are of the same size, the only advantage is a choice of directions from which the energy may come. If the pulleys are of different sizes, an advantage of either speed or force may be obtained. Crossing the rope or belt that runs between the two pulleys reverses the direction of turn of the driven pulley.

The second basic type of pulley is a *movable pulley.*



WORLD BOOK illustration by Sarah Woodward

A simple pulley is shown in Figure 1. Figure 2 shows a fixed pulley that merely changes the direction of the force applied to the load (L). It has a mechanical advantage of 1. Figure 3 is a movable pulley from which the load is suspended.

The load is attached to the axle of this pulley. One end of the rope that passes through the pulley is attached to a fixed support above the load. A pull is applied to the free end of the rope in the same direction the load is to move. The mechanical advantage of a movable pulley is 2. This means that the pull applied to the free end of the rope need be only half the weight of the load. The rope attached to the fixed support also carries half the weight of the load. James D. Chalupnik

See also **Block and tackle; Machine** (picture).

Pullman, George Mortimer (1831-1897), was an American businessman remembered chiefly in connection with the railroad sleeping car. He came to control the business of railroad sleeping cars when trains were a major means of transportation in the United States.

Pullman was born in Brocton, New York. He became a cabinetmaker and then worked as a construction contractor. Moving to Chicago in 1855, he became interested in improving railroad sleeping cars. In 1858, he remodeled two coaches into sleeping cars for the Chicago & Alton Railroad. Pullman and a friend, Ben Field, then designed a more elaborate sleeping car which they named *Pioneer.* It entered service in 1865. The car was converted from day to night use by swinging down the upper berths, folding the seats to make them into lower berths, and separating the berths by curtains.

Pullman started the Pullman Palace Car Company (later called the Pullman Company) in 1867. This firm built, staffed, and operated sleeping cars on all major railroads. In 1868, Pullman introduced a dining car that had a kitchen. His firm introduced parlor cars in 1875 and the vestibule for direct connection between cars in 1887.

By 1899, Pullman possessed a virtual monopoly on the sleeping-car business in the United States. His manufacturing plant was in Pullman, Illinois, a town built and owned by the Pullman Company that is now part of Chicago. John H. White, Jr.

See also **Pullman Strike.**

Pullman Strike, also called the Chicago Strike, was a violent labor dispute that took place in 1894. The strike involved the Pullman Company, which manufactured railroad cars near Chicago, and the American Railway Union (ARU). The ARU was a group of railroad workers who were led by Eugene V. Debs. The strike began when employees of the Pullman Company refused to re-

turn to work, to protest a reduction in their wages. In sympathy with the employees, the ARU refused to haul railroad cars made by the company. A general railroad strike resulted.

The railroad strike interfered with mail trains. A federal court ordered leaders of the ARU to call off the strike but they refused. President Grover Cleveland sent federal troops to protect the mail and maintain law and order. When the troops arrived in the Chicago area, violence erupted and much railroad property was destroyed. Debs and other union leaders were then arrested for refusing to obey the court order. The government actions ended the strike. The settlement demonstrated the power of the U.S. government to intervene against strikes that threatened the public interest. David Brody

See also **Debs, Eugene V.**; **Labor movement** (picture).

Pulp. See **Paper** (How paper is made; diagram); **Forest products** (Paper and paperboard).

Pulsar, *PUHL sahr,* is an object in space from which regular bursts of electromagnetic radiation are received on the earth. Most of this radiation is in the form of radio waves. Pulsars received their name from these highly regular pulses.

Scientists believe pulsars are rapidly spinning *neutron stars,* dense stars composed primarily of tightly packed neutrons, or perhaps of elementary particles called *quarks* (see **Neutron star**; **Quark**). An extremely powerful magnetic field surrounds the neutron star and rotates with it. This rapidly rotating magnetic field produces a strong electric field that rips electrons and protons from the star's surface. As these particles flow from the star, they emit energy in the form of a narrow beam of radio waves. The beam rotates as the star spins. Using a radio telescope, an astronomer can detect a pulse of radio waves each time the pulsar rotates and the beam sweeps past the earth.

On the average, radio pulsars spin at the rate of twice a second. All radio pulsars eventually lose energy and slow down. They do so in such a predictable manner that their pulses can be used to measure time.

The strong gravity of a pulsar can capture gases from a nearby companion star. These gases crash into the pulsar, creating hot spots that send out beams of X rays. X rays are like radio waves but have much shorter wavelengths. Some pulsars gain momentum and rotate faster as they capture gases from companion stars. These pulsars, called *millisecond pulsars,* rotate hundreds of times per second. Scientists believe many millisecond pulsars occur in high concentrations of stars known as *globular clusters.*

Astronomers study pulsars to determine the motions of objects at the centers of globular clusters and to learn about the matter between stars in the Milky Way. Astronomers also study how pulsars turn their enormous rotational energy into radio beams.

Radio pulsars were discovered in 1967 by British astronomers Jocelyn Bell (later Bell Burnell) and Antony Hewish at Cambridge University. In 1992, astronomer Alexander Wolszczan of Pennsylvania State University announced evidence that three planets are orbiting a pulsar called PSR B1257+12. The pulsar is in the constellation Virgo and is about 1,300 *light-years* from the earth. One light-year is the distance that light travels in one year—about 5.88 trillion miles (9.46 trillion kilometers).
Daniel R. Stinebring

Pulse is caused by a stretching of the arteries that takes place after each heartbeat. It can be felt by placing the fingers on the wrist above the thumb at a point over the *radial artery.* The pulse also can be felt by touching the temples where the *temporal artery* is located, and at other places in the body where an artery is near the surface.

Each heartbeat consists of a contraction of the muscles of the heart that propels the blood into the arterial system, followed by a period of relaxation during which the heart refills. As the heart contracts, the blood is pumped into the *aorta* and *pulmonary arteries.* The aorta, the largest artery in the body, carries the blood aerated in the lungs from the left side of the heart to the rest of the body. As the blood rushes into the aorta, its elastic walls are stretched and it expands to make room for the blood. As the blood moves on to enter the arteries that branch off from the aorta, the walls relax and it contracts to normal size. The walls of these arteries and of their branches also expand and contract as the blood passes through them. The expansion of these arteries causes the pulsation known as the *pulse.*

The pulse rate of children is faster, and that of old people often is slower than that of the average healthy adult. While pulse rates between 50 and 85 per minute are considered within normal limits, the normal rate for the average man is about 72. The pulse of the average woman is a little faster—76 to 80 per minute. The pulse rate of a newborn child may be as high as 140 per minute. The normal rate for a seven-year-old child is about 90 per minute. Slower pulse rates of from 50 to 65 per minute are not unusual in elderly people. But regardless of a person's age, the pulse and heart rhythm should be regular.

A doctor feels a patient's pulse to find out if the heart is beating normally. If the pulse is too fast, too slow, or irregular, the doctor examines the patient to diagnose the cause of the abnormal pulse. Dominick Sabatino

See also **Artery**; **Heart**.

Puma. See **Mountain lion**.

Pumice, *PUM ihs,* is a grayish-white natural glass with many tiny holes. It is a valuable scouring, scrubbing, and polishing material in both powdered form and as pumice stone. Pumice forms when lava from a volcano flows onto the earth's surface or erupts violently into the air. The hot, gas-filled lava then cools quickly to form glass. Many tiny holes remain after the volcanic gases escape from the cooling lava. Marilyn M. Lindstrom

See also **Rock** (picture).

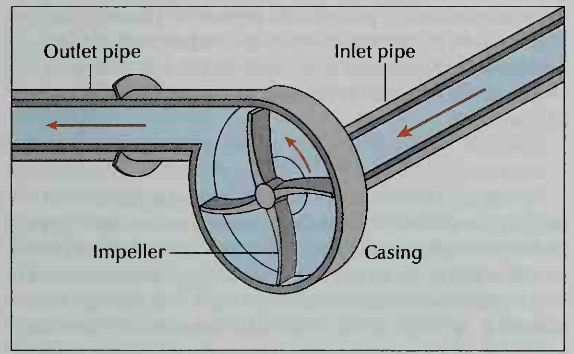
Pump is a device that moves liquids and gases. Pumps are used in a variety of machines and other devices, including home heating systems, refrigerators, oil wells and water wells, and turbojet and automobile engines. The fluids that are moved by pumps range from air for inflating bicycle tires to liquid sodium and liquid potassium used for cooling nuclear reactors. Most pumps are made of steel, but some of them are made of glass or plastic. Gas pumps are also called *compressors, fans,* or *blowers.*

There are two major types of pumps—*dynamic pumps* and *positive displacement pumps.* Dynamic pumps maintain a steady flow of fluid. Positive displace-

ment pumps, on the other hand, trap individual portions of fluid that are in an enclosed area before moving them along.

Dynamic pumps

Centrifugal pumps consist of a motor-driven propellerlike device, called an *impeller,* which is contained within a circular housing. The impeller is a wheel of curved blades that rotates on an axis. Before most centrifugal pumps can start pumping liquid, they must be *primed* (filled with liquid). As the impeller rotates, it creates suction that draws a continuous flow of fluid through an inlet pipe. Fluid enters the pump at the center of the impeller and travels out along the blades due to *centrifugal* (outward) force. The curved ends of the blades then sweep the fluid to an outlet port.



WORLD BOOK illustration by Mark Swindle

A centrifugal pump consists of a rotating device called an *impeller* within a circular casing. Fluid enters the pump near the center of the impeller, which sweeps it to an outlet pipe.

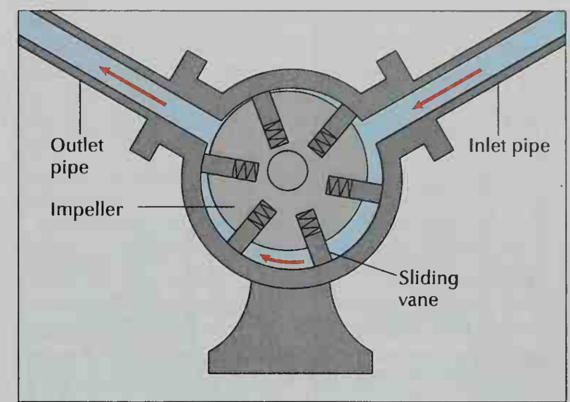
Centrifugal pumps are inexpensive and can handle large amounts of fluid. They are widely used in chemical-processing plants and oil refineries.

Axial-flow pumps have a motor-driven rotor that directs fluid along a path parallel to its axis. The fluid thus travels in a relatively straight path from the inlet pipe through the pump to the outlet pipe.

Axial-flow pumps are most often used as compressors in turbojet engines. Centrifugal pumps are sometimes used for this purpose, but axial-flow pumps are more efficient. Axial-flow compressors consist of alternating rows of rotors and stationary blades. The blades and rotors produce a pressure rise in the air as it moves through the axial-flow compressor. Air then leaves the compressor under high pressure. See **Jet propulsion** (Turbojet).

Jet pumps get their name from the way they move fluid. These pumps operate on the principle that a high-velocity fluid will carry along any other fluid it passes through. Most jet pumps send a jet of steam or water through the fluid that needs to be moved. The jet carries the fluid with it directly into the outlet pipe and, at the same time, creates a vacuum that draws more fluid into the pump. The amount of fluid that is carried out of most jet pumps is several times the amount of fluid that is in the jet itself.

Jet pumps can be used to raise water from wells that are deeper than 200 feet (60 meters). In such cases, a centrifugal pump at ground level supplies water for a jet at the bottom of the well. The jet carries well water with it back up to ground level.



WORLD BOOK illustration by Mark Swindle

A sliding vane pump contains a slotted impeller. Sliding *vanes* (blades) are attached to the impeller by springs. They move in and out of the slots as the impeller rotates.

Jet pumps are also used in *high-vacuum diffusion pumps* to create a vacuum in an enclosed area. In high-vacuum diffusion pumps, a high-velocity jet of mercury or oil vapor is sent into the enclosed area. The vapor molecules collide with the molecules of air and force them out the outlet port.

Electromagnetic pumps are used chiefly to move liquid sodium and liquid potassium, which serve as coolants in nuclear reactors. Electromagnetic pumps consist of electrical conductors and magnetized pipes. The conductors send current through the fluid. This causes the fluid to become an electromagnet. The fluid is then moved by the magnetic attraction and *repulsion* (pushing away) between the fluid's magnetic field and the magnetic field of the pipes. The fluid is therefore moved in an electromagnetic pump in much the same way as an armature is moved in an electric motor (see **Electric motor**).

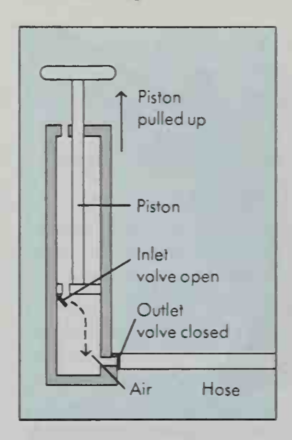
Positive displacement pumps

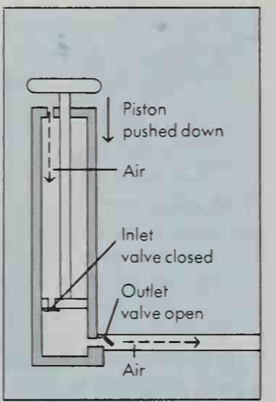
Rotary pumps are the most widely used positive displacement pumps. They are often used to pump such *viscous* (sticky) liquids as motor oil, syrup, and paint. There are three main types of rotary pumps. These types are: (1) gear pumps, (2) lobe pumps, and (3) sliding vane pumps.

Gear pumps consist of two gears that rotate against the walls of a circular housing. The inlet and outlet ports are at opposite sides of the housing, on line with the point where the teeth of the gears are fitted together. Fluid that enters the pump is trapped by the rotating gear teeth, which sweep the fluid along the pump wall to the outlet port.

Lobe pumps operate in a manner similar to gear pumps. However, instead of gears, lobe pumps are equipped with impellers that have *lobes* (rounded projections) fitted together. Lobe pumps can discharge large amounts of fluid at low pressure.

Sliding vane pumps consist of a slotted impeller mounted off-center in a circular housing. Sliding *vanes* (blades) move in and out of the slots. As the vanes rotate by the inlet port, they sweep up fluid and trap it against





WORLD BOOK illustrations by Arthur Grebetz

A bicycle tire pump has a piston that moves up and down. When the piston is raised, the air above it flows to the bottom of the pump. When it moves down, air is forced out the hose.

the pump wall. The distance between the impeller and the pump wall narrows near the outlet port. As the fluid is carried around to this port, the vanes are pushed in and the fluid is compressed. The pressurized fluid then rushes out the outlet port.

Reciprocating pumps consist of a piston that moves back and forth within a cylinder. One end of the cylinder has an opening through which the *connecting rod* of the piston passes. The other end of the cylinder, called the *closed end,* has an inlet valve or an outlet valve, or both valves, depending on the type of pump. In certain types of reciprocating pumps, the inlet valve or the outlet valve is located on the piston. Common reciprocating pumps include lift pumps, force pumps, and bicycle tire pumps.

Lift pumps draw water from wells. In a lift pump, the inlet valve is at the closed end of the cylinder and the outlet valve is on the piston. As the piston is raised, water is drawn up through the inlet valve. As the piston moves down, the inlet valve closes, forcing water through the outlet valve and up above the piston. As the piston is raised again, the outlet valve closes and the water is lifted to an opening, where it leaves the pump. At the same time, more water is drawn through the inlet valve.

It is theoretically possible for a lift pump to raise water in a well almost 34 feet (10.4 meters). However, because of leakage and resistance, a lift pump cannot raise water that is deeper than about 25 feet (7.6 meters).

Force pumps are similar to lift pumps. However, in force pumps, both the inlet valve and the outlet valve are at the closed end of the cylinder. As the piston moves away from the closed end, fluid enters the cylinder. When the piston moves toward the closed end, the fluid is forced out the outlet valve.

Bicycle tire pumps vary in the number and location of the valves they have and in the way air enters the cylinder. Some simple bicycle tire pumps have the inlet valve on the piston and the outlet valve is located at the closed end of the cylinder. Air enters the pump near the point where the connecting rod passes through the cylinder. As the rod is pulled out, air passes through the piston and fills the areas between the piston and the outlet valve. As the rod is pushed in, the inlet valve closes and the piston forces air through the outlet valve of the pump.

History

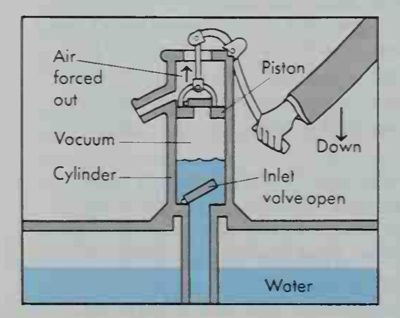
Pumping devices have been an important means of moving fluids for thousands of years. The ancient Egyptians used water wheels with buckets mounted on them to move water for irrigation. The buckets scooped water from wells and streams and deposited it in ditches that carried it to fields. In the 200's B.C., Ctesibius, a Greek inventor, made a reciprocating pump for pumping water. About the same time, Archimedes, a Greek mathematician, invented a screw pump that was made up of a screw rotating in a cylinder (see **Archimedean screw**). This type of pump was used to drain and to irrigate the Nile Valley.

True centrifugal pumps were not developed until the late 1600's, when Denis Papin, a French-born inventor, made one with straight vanes. The British inventor John G. Appold introduced a curved-vane centrifugal pump in 1851. Axial-flow compressors were first used on turbojet engines in the 1940's. Marian Visich, Jr.

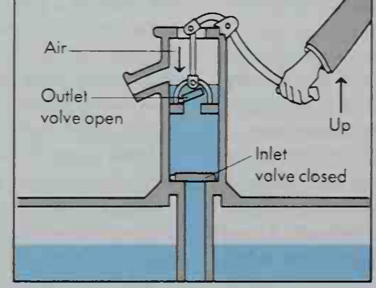
See also **Milking machine; Well.**

Pumpkin is a vegetable related to squash. Pumpkin plants produce round or oval fruits, also called *pumpkins,* that have hard shells and coarse, stringy pulp. A

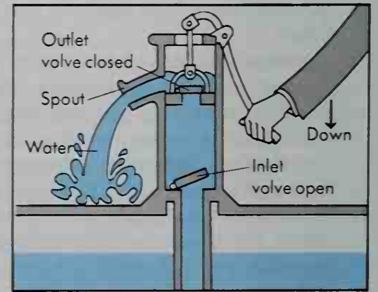
How a lift pump works Lift pumps are used to draw water from some wells. The outlet valve is on a piston, which moves up and down in the pump's cylinder. The inlet valve is at the closed end of the cylinder.



When the handle is pushed down, the piston rises and forces out air. Water enters the cylinder to replace the air.



Pulling up on the handle lowers the piston through the water. Force closes the inlet valve and opens the outlet valve.



WORLD BOOK illustrations by Arthur Grebetz

Pushing down on the handle raises the piston, and the water above the piston pours out the spout.

central cavity within the fruit holds the seeds. Most pumpkins weigh from 5 to 30 pounds (2.3 to 14 kilograms). However, some may weigh more than 1,000 pounds (450 kilograms). The majority of pumpkins are orange, but many pumpkins are white, yellow, or other colors.

Pumpkins are rich in vitamin A and potassium. People cook pumpkins in various ways, especially as pumpkin pie. Pumpkin seeds, a popular snack, provide protein and iron. Especially popular are the hull-less seeds that do not have a hard coat or outer shell. In the United States, people of all ages enjoy carving pumpkins into jack-o'-lanterns to celebrate Halloween.

Pumpkin plants have large, prickly leaves and produce male and female flowers. Only the male pumpkin blossoms have pollen that is transferred by bees to the female flowers. Pollinated female blossoms develop into pumpkins. But each female flower opens for pollination for only one day. In addition, most pumpkin blossoms are male. As a result, few flowers actually produce pumpkins.

Pumpkins grow on both vines and bushes. Pumpkins that grow on vines are planted in mounds about 12 feet (3.7 meters) apart. Bush varieties are spaced closer together. Pumpkin plants need careful cultivation to produce healthy fruit. The plants thrive in slightly acid soil, and most of them mature about four months after the seeds are planted. Ripe pumpkins that are well developed can be stored at 40 to 50 °F (4 to 10 °C) for several months.

Pumpkins probably originated in North America. Seeds from related plants dating back to 7000 to 5500 B.C. have been found in Mexico. Albert Liptay

Scientific classification. Pumpkin plants belong to the gourd family, Cucurbitaceae. The scientific names of the four pumpkin species are *Cucurbita pepo, C. mixta, C. moschata,* and *C. maxima.*

See also Squash.

Pumpkinseed. See Sunfish.



WORLD BOOK illustration by Kate Lloyd-Jones, Linden Artists Ltd.

Pumpkins have a hard outer shell and coarse, stringy pulp. People cook pumpkins in a variety of ways, especially as pumpkin pie. In addition, pumpkin seeds are a popular snack.

Pun is a humorous use of words that sound alike or nearly alike but have different meanings. For example, a rascally character in William Shakespeare's play *Henry V* says, "To England will I steal, and there I'll steal." A pun also may be called a *play on words.* Because a pun condenses more than one meaning into one word, an author can use a pun to present several ideas in a single expression.

Some literary critics, particularly those of England during the 1700's, have called the pun "the lowest form of wit." However, many of the world's greatest writers have frequently used puns. For example, some of the most delightful passages in Shakespeare's early comedies are those in which characters indulge in punning contests. The Irish novelist James Joyce filled his novel *Finnegans Wake* (1939) with clever puns in several languages. Marcus Klein

See also **Humor** (Puns).

Punch and Judy are the main characters in a type of comic puppet show popular in England. Punch is a hook-nosed hunchback who wears a traditional Italian costume. Judy is his wife. A typical Punch-and-Judy show has much rough, violent humor. In the show, Punch usually beats his child, quarrels with his wife, and kills her and sometimes other characters. Punch is brought to trial and sentenced to death, but escapes punishment through trickery.



Robert Harding Picture Library

Punch and Judy are popular puppet characters, especially in England. A typical Punch-and-Judy show is filled with violent comedy involving the quarrelsome Punch, his wife, and baby.

The character of Punch combines English, French, and Italian influences. His name came from Pulcinella, a popular character in Italian theater during the 1600's. Punch-and-Judy puppet shows were introduced into England from continental Europe in 1662. By the 1800's, Punch-and-Judy shows were being presented in portable puppet theaters at fairs or on the streets throughout England. By 1742, Punch-and-Judy shows were brought to America, but they never gained the popularity they enjoyed in Britain. Don B. Wilmeth

See also **Puppet** (Hand puppets).

Punctuation is the use of certain marks in writing and printing to make the writer's meaning clear. The marks are also called *punctuation.*

Early writing and early printing had marks to show punctuation. But the signs were used according to the wish of the writer and to the marks that the printers had

in their typecases. The ancient Greeks, for example, often used a semicolon in place of our modern question mark. Printing and punctuation improved rapidly during the 1400's and 1500's, especially in Italy. During this period, Aldus Manutius, an Italian printer and bookmaker, began to use the various marks more systematically. His work formed the basis of the punctuation used today in many written language systems.

Punctuation marks were used more frequently some years ago. Today, the trend is to use fewer and fewer marks, and in many places to use none at all. Writers today are less bound by the old rules.

The period (.) is used at the end of a statement or command and after most abbreviations. A period follows the sentence you have just read. In American usage, if there are quotation marks at the end of a sentence, the period is placed inside these marks. In British and Australian usage, the period is placed outside the marks. Roman numerals (clxvi, CXXVI) are not followed by periods. Periods are not placed after page numbers in books, but they are placed after numbers in an outline or list. There are no periods after call letters for radio stations, some government bureaus, and some signals sent by code letters, such as *WCFL, FBI,* and *S O S.* Some people, such as printers, call the period the "full stop."

The question mark (?) is used after a question. It is also called the *interrogation mark* or *point.* Every direct question should be followed by a question mark, as *Do you understand this rule?* An indirect question does not end in a question mark. It is followed by a period, as *Inspector Adams wondered who did it.*

The exclamation point (!) is used after a sentence that expresses strong feeling. *How cold it is!* Single words, phrases, or clauses of the same sort are followed by the exclamation point. *Listen! You, over there! Trying to hide!* There are few occasions for using an exclamation point, except in reporting speech.

Quotation marks (" ") enclose the exact words of a speaker. They are sometimes called *double quotation marks,* or *double quotes.* They enclose only the spoken words, as in *"I'm going to telephone Martha," said Bill,* and *"Do you think," Mother asked, "that she has come back from the shore?"*

Quotation marks are used when material is taken word-for-word from another source. For example, an author uses quotation marks to set off text that originated with another author. When several paragraphs are quoted, quotation marks are placed at the beginning of every paragraph and at the end of the last quoted paragraph. Quotations within quotations are enclosed in single quotation marks, as in *"He answered, 'I will not,' when I asked him," she reported.*

Quotation marks may enclose titles of short written works, such as poems, lectures, sermons, and short stories. Quotation marks also call attention to unusual uses of words, such as *a famous "first,"* and to identify nicknames, as in *Eric was called "The Red" because he had red hair.*

The colon (:) has two uses. It is most frequently used after the salutation in a business letter, as *Dear Mrs. Miller:, Gentlemen:, My dear Doctor:, Dear Sir:* . The other use is after such expressions as *to the following:, as follows:* . Often the colon in this use is followed by a list. *The world's three largest countries in area are as follows: Russia, Canada, China.* See **Colon.**

The semicolon (;) is used in a compound sentence between two principal clauses that are not joined by a conjunction. *He struggled to land the bass; it flipped its tail as it vanished.* If principal clauses of a compound sentence contain commas, a semicolon is placed between the clauses even if the conjunction is used. *We rounded the corner yelling, swaying, and grinding; but having used the brakes too late, we skidded against the opposite wall.* The semicolon is also used instead of the comma after items in a series when these items are long or complicated.

The dash (—) is used to mark a sudden break in thought. *I considered her—it was a foolish opinion—too young to take care of herself.* Use dashes to set off emphatically any definition or enumeration in a sentence: *The work of two great English historians—Edward Gibbon and Thomas B. Macaulay—interested Churchill the most.*

Parentheses () enclose parts of the sentence which might easily have been omitted. The material between them is not connected grammatically with the rest of the sentence. *I explained to you (you don't remember when) why I cannot take a long trip.* One mark is called a *parenthesis.* The entire group of words enclosed by the marks is also called a *parenthesis.*

Brackets [ ] in quoted remarks enclose explanations not in the actual speech. *I am a simple man. [Laughter].* Directions in plays may be enclosed in parentheses or in brackets. *But I need money. [He turns away.]*

The comma (,) is the most commonly used mark. It has more uses than any other mark of punctuation. Most of the principal ones are set down here.

It follows the words, phrases, or clauses in a series. *We ate crabs, lobster, shrimp, and fish.*

It follows items in addresses and dates. *He was born at 611 East Minnesota Street, Indianapolis, Indiana, on November 24, 1911.*

It is placed around certain conjunctions, adverbs, and phrases, such as *now, however, for instance,* when it indicates a break in the construction. *Try, for instance, to borrow money without giving security.*

It is used after words, phrases, and clauses at the beginning of sentences unless there is a close connection. *If you perform that experiment again, I shall help you.*

It is used between the principal clauses of a compound sentence unless the sentence is short. *We stood terrified by the swollen stream, but one of us discovered a safe bridge along a huge fallen tree.*

It separates nonrestrictive subordinate clauses from the rest of the sentence. *The listening lad, who had been intently silent, suddenly let out a bloodcurdling yell.*

It sets off a word or phrase which explains some term. The second term is said to be an *appositive* of the first. *Radar, an electronic device, is of value in warfare.*

It sets off words like *well, yes, no,* and all nouns of address. *Yes, we saw the eclipse. Mr. Emerson, may I speak with Jane?*

It sets off quotations, especially in conversation. *"May I," he began shyly, "have the next dance?" "Surely," she answered.*

It is often used to avoid misunderstanding. *Some weeks before she arrived from Canada* is not clear.

Some weeks before, she arrived from Canada is clear.

The hyphen (-) is most commonly used to link compound words, such as *twenty-three, Anglo-American,* and *forget-me-not.* It is also used at the end of a line when a word is broken into syllables and part of the word is put on the next line, as in *atti-tude, di-vision.*

The apostrophe (') is used in the place of omitted letters in contractions, as in *can't, she'll, they're.* It also substitutes for omitted letters in words used in poetry, as in *th', ev'ry,* and *'tis.* The apostrophe is also used to show the possessive case, as in *the student's book, the birds' song, the children's room.* Marianne Cooley

Punic Wars, *PYOO nihk,* were three struggles between ancient Rome and Carthage. Rome won all three wars. The victories made Rome the supreme power of the western Mediterranean and helped Rome gain control of the entire Mediterranean world. *Punic,* the Latin word for *Phoenician,* is used for the wars because Carthage had been founded by the Phoenicians.

The First Punic War (264-241 B.C.) began when Rome intervened to prevent Carthage and Syracuse, a city on the island of Sicily, from controlling the Strait of Messina. The strait lay between Sicily and Italy. Rome became a naval power to meet Carthage on equal terms. Both sides lost several fleets and many men. The war was decided when Rome conquered Sicily and won a final naval battle there.

The Second Punic War (218-201 B.C.) developed from the first war and was caused in part by territorial rivalry in Spain between Rome and Carthage. Hannibal, a great Carthaginian general, crossed the Alps and invaded Italy. The Romans defeated him in the Battle of Zama in 202 B.C. Carthage then paid Rome a large sum and gave up Spain.

The Third Punic War (149-146 B.C.) resulted when Carthage rebelled against the restrictions of the Roman peace treaty of 201 B.C. Carthage was completely destroyed in this war.

Rome won the Punic Wars because it had better resources and more soldiers. Carthage was richer in the beginning, but it had to rely on *mercenaries* (hired troops). Hannibal had proved that mercenaries could fight well, but there were never enough of them.

Arthur M. Eckstein

Related articles in *World Book* include:

Carthage
Hamilcar Barca
Hannibal
Regulus, Marcus Atilius
Rome, Ancient (Expansion overseas)
Scipio Africanus, Publius Cornelius

Punishment. See **Capital punishment; Crime; Penal colony; Prison; Reformatory; Sentence** (in law).

Punjab, *PUHN jahb* or *puhn JAHB,* is a region that lies in northwestern India and in Pakistan. The name *Punjab* comes from a Sanskrit word that means *five rivers.* The area is mostly flat, and it is drained by the Indus River and its five tributaries. For location, see **India** (political map); **Pakistan** (political map).

Punjab (Pakistan) (pop. 47,292,441; area 79,284 mi², or 205,345 km²) is a province of Pakistan. Lahore, which is the largest city in the province, has a number of cotton gins and presses. The city also has factories that manufacture textiles, cement, glass, and surgical goods. Islamabad, another city in Punjab, serves as the capital of Pakistan.

The leading economic activity of the province is farming. Punjab province is the leading wheat-producing area of the Indian subcontinent. Millet, maize (corn), sugar cane, oilseeds, rice, citrus fruit, mangoes, pomegranates, dates, and cotton also are grown. Widespread irrigation has made much of the land fertile. From 1950 to 1953, for example, 2 million acres (810,000 hectares) of desert land were reclaimed by irrigation. Minerals, such as coal, gypsum, and limestone, are in the northwestern section of the province.

Punjab (India) (pop. 45,372,285; area 36,515 mi², or 94,574 km²) is a region that consists of two states—Punjab, where Punjabi is spoken, and Haryana, where Hindi is spoken. These states were created from the single state of Punjab in 1966. A portion of the original Punjab state was also included in the territory of Himachal Pradesh.

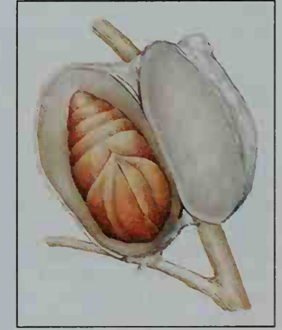
Indian Punjab is largely a farming region. Timber is found in the northeast part. Cities of Indian Punjab include Amritsar, the holy city of the Sikhs; and Chandigarh, the capital of Punjab and Haryana states. Chandigarh is also a Union Territory of India. Indian Punjab has cotton mills, small engineering plants, metalworks, and glassworks. It also produces cement, sporting goods, and handicrafts, such as carpets and turbans.

Part of the Punjab region was once within the empire of Alexander the Great. Later, Mughal rulers held the area. In the early 1800's, it became a Sikh kingdom under Ranjit Singh. The United Kingdom annexed it in 1849. When India was partitioned in 1947, Punjab also was divided. The eastern section became an Indian state, while the western area, dominated by the Muslims, went to Pakistan. Thousands died as Muslims fled from eastern Punjab, and Hindus and Sikhs moved from Pakistan to India. Sikhs in Punjab have demanded that the Indian government grant them greater control over their own affairs. Violence has occurred from time to time between Sikhs and Indian government forces (see **India** [India under Indira Gandhi]). Robert LaPorte, Jr.

See also **Amritsar; Indus River; Lahore.**

Pupa, *PYOO puh,* is the relatively inactive stage in the *metamorphosis* (development) of most insects. In *complete metamorphosis,* the larva feeds until fully grown (see **Larva**). It then molts into the pupa, a temporary form in which the adult structures develop. The adult insect emerges by splitting open the pupal "skin" and crawling out. The pupal stage may last a day or two, or up to one or more years, depending on the species. This stage enables some adult insects, such as butterflies, to have features that differ greatly from those of the larva. It also allows the developing insect to avoid such conditions as extreme heat and cold, famine, and drought.

The pupa looks different in different species. Butterfly and moth pupae are mummylike with the wings, antennae, and legs encased in the pupal shell.



WORLD BOOK illustration by Shirley Hooper, Oxford Illustrators Limited

Pupa

The pupae of beetles, lacewings, and bees have legs and antennae that hang free. Many insects form a cocoon of silk or other materials and pupate in it. Most moths form cocoons. The butterfly pupa, called a *chrysalis,* hangs from a silklike pad and does not have a cocoon. The housefly and related flies inflate the next-to-last larval skin to form a cocoon called a *puparium.*

Charles V. Covell, Jr.

See also **Butterfly** (The pupa; picture); **Chrysalis; Cocoon; Fly** (Pupa; picture); **Metamorphosis; Moth** (The pupa; picture).

Pupfish is any of about 30 species of small fish that live mainly in springs and streams in the Southwestern United States and Mexico. Pupfish have inhabited these waters since the last Ice Age, about 50,000 years ago. At that time, rivers and lakes covered the area, much of which is now desert. Isolated groups of pupfish survived after most of the water had dried up. One species, the *Devils Hole pupfish,* has lived over 20,000 years in a deep spring in Nye County, Nevada. This area is now in Death Valley National Park.

Several species of pupfish have become extinct, and other species are endangered. In the 1970's, scientists and conservationists began working to protect the surviving species. The Devils Hole pupfish has been legally protected since 1976. The population of this species has been reduced to only about 200 individuals at times.

Pupfish can live in water where few plants and animals can survive. Some pupfish normally withstand water temperatures up to 108 °F (42 °C). Pupfish have an average length of about 1 $\frac{1}{2}$ inches (3.8 centimeters). The females and young are olive brown and white, with black bars on their sides. The males are blue and purple, with black bars and dark-edged fins.

Scientific classification. Pupfish belong to the killifish family, Cyprinodontidae. They are genus *Cyprinodon.* The scientific name for the Devils Hole pupfish is *C. diabolis.* The Salt Creek pupfish is *C. salinus.* Tomio Iwamoto

Pupil. See **Eye** (The uveal tract; picture: The iris).

Pupin, *pyoo PEEN,* **Michael Idvorsky,** *ihd VAWR skee* (1858-1935), was a Serbian-American electrical engineer, educator, and inventor. In 1900, he patented the *loading coil,* a device that improved telephone sound quality and enabled people to talk on the telephone over much greater distances than before. Pupin came to the United States in 1874 and taught at Columbia University from 1889 to 1931. In 1924, he received a Pulitzer Prize for his autobiography, *From Immigrant to Inventor* (1923). He was born in Idvor, north of Belgrade in what became Yugoslavia. James E. Brittain

Puppet is an artificial figure whose movements are controlled by a person. Puppets can be moved by hand or by strings, wires, or rods. A figure may represent a person, an animal, a plant, or an object. Puppets usually appear as characters in plays called *puppet shows.* A person who operates a puppet is called a *puppeteer.*

Many children make puppets from such cheap materials as paper, cloth, and wood, or from such items as milk cartons and rags. They write puppet shows and operate the puppets, varying their voice for each character. A table or bookcase can serve as a stage. A puppeteer can also work behind a blanket or sheet tacked across the lower part of a doorway. The puppeteer is concealed, and so the audience sees only the puppets performing in the upper part of the doorway.

Some teachers use puppets to make schoolwork more interesting. For example, a history class may use puppets to act out a famous historic event. Students can improve their knowledge of a foreign language by writing and performing puppet shows in that language. Creating a voice for a puppet has helped some students overcome a speech problem. In underdeveloped countries, puppet shows have been used to teach health care, modern farming methods, and other subjects.

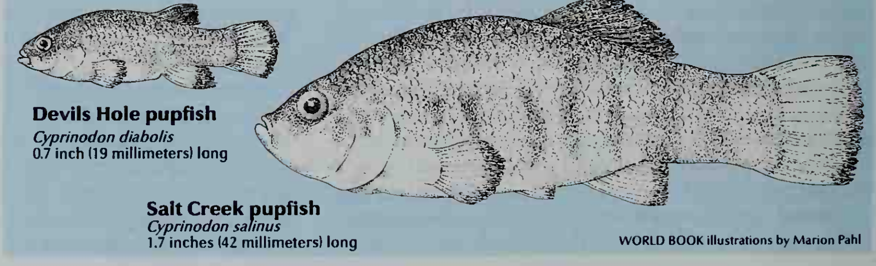
People have enjoyed puppets for thousands of years. Puppetlike figures have been found in tombs and ruins in ancient Egypt, Greece, and Rome. The first puppets were probably used in religious ceremonies. Priests secretly moved the eyes or arms of an idol or religious carving to impress the people watching.

There are three main kinds of puppets: (1) hand puppets, (2) marionettes, and (3) rod puppets. Many puppets have features of more than one type.

Hand puppets are the most common puppets. One variety, the *glove* or *fist* puppet, consists of a hollow head attached to a glove or a piece of cloth that serves as the puppet's body. The body fits over the hand of the puppeteer, who puts a thumb into one of the puppet's arms. One or two fingers go into the other arm, and the remaining fingers are placed in the head. These puppets can pick up things and can gesture with their head and arms. Most glove puppets have no legs or feet.

Perhaps the most famous glove puppet character is Punch, the star of English puppet shows called *Punch and Judy shows.* Punch was introduced into England in 1662 (see **Punch and Judy**). Puppet characters that resemble Punch are popular in several countries, including France, Germany, Italy, the Netherlands, and Switzerland. Glove puppets have become a popular feature of several children's television programs, such as "Sesame Street" and "Captain Kangaroo."

The simplest kind of hand puppet is probably the *finger puppet.* Some finger puppets fit over the upraised finger with the face over the fingernail. In others, two



Pupfish have lived in the waters of southwestern North America for thousands of years. The *Devils Hole pupfish* is found only in a small spring in Nevada. The *Salt Creek pupfish* lives in a California stream where temperatures reach over 100 °F (38 °C).



Salzburg Marionette Theater, Austria

Marionettes are moved by strings or wires attached to their body and controlled by puppeteers who are hidden above the stage. The scene at the left shows three women battling a serpent in a marionette version of the opera *The Magic Flute.*

fingers serve as the puppet's legs. The face may be painted on the back of the hand, or a paper head can be fastened with a rubber band.

Another type of hand puppet, the *muppet,* was developed for television by the American puppeteer Jim Henson. This small puppet, usually made of foam rubber or other soft material, has a wide mouth, with the puppeteer's thumb inside the lower jaw. The fingers form the upper part of the muppet's face. The puppeteer moves various fingers to change the muppet's expression and the shape of its head. The puppeteer's other hand, which is concealed in a glove, forms the muppet's body or hand. See **Henson, Jim.**

Marionettes are puppets controlled by strings or, in some cases, by wires. A marionette has a complete body, with head, trunk, arms, hands, legs, and feet. Strips of cloth, leather, or other flexible material connect the various parts of the marionette's body. Most marionettes have strings that run from the head, shoulders, hands, and knees to *the control,* a small wooden frame. One or more puppeteers, who are hidden above the stage, operate the marionettes by moving the strings where they are fastened to the control.

The word *marionette* comes from *Little Mary,* a type of puppet of the Middle Ages. During this period, many people could not read or write. Priests used Little Marys to teach stories from the Bible. Marionette shows gradually became comic plays that were intended to entertain rather than teach religious lessons. But the plays grew so coarse and worldly that religious authorities refused to let them be performed in churches. Marionette shows then became *street entertainments* that were performed in parks and at fairs.

Rod puppets are operated by rods or sticks, usually from below the stage. One kind of rod puppet, the *marotte,* consists only of a head mounted on a stick. Some rod puppets have rods attached to movable arms and hands. Rod puppets are often used to represent figures other than people and animals. For example, they may portray clouds, flowers, hats, trees, or just simple shapes.

Japan has a well-known form of puppet show called *bunraku* (doll theater). The puppets stand about 4 feet (120 centimeters) tall. They look realistic, with flexible joints and movable eyes, mouth, and eyebrows. As many as three puppeteers operate them with rods from behind, in full view of the audience. Many important Japanese dramatists of the late 1600's and 1700's wrote plays especially for the doll theater. See **Drama** (Asian drama [Japan]).

Shadow plays are a type of puppet show in which all types of puppets can be used. The puppeteer operates the puppet against a thin screen made of silk or cotton. A strong light shines on the screen from behind and above. The audience, which sits on the other side of the screen, sees only the moving shadows of the puppets.

One kind of puppet, a flat figure made of leather, is made especially for shadow plays. Such puppets, which are popular in Asia, may have movable parts operated by rods made of bamboo or animal horn. The Chinese



Martine Franck, Woodfin Camp, Inc.

Rod puppets are featured in a traditional form of Japanese theater called *bunraku, above.* Puppeteers use rods to operate the figures, which stand about 4 feet (120 centimeters) tall. The puppeteers, dressed in black, work in full view of the audience.



Victor Englebert, De Wys, Inc.

Shadow puppets perform behind a screen. A light from above and behind the puppets creates shadows on the screen. The audience sees only the shadows. Shadow plays based on Hindu myths, *shown here,* are the most popular form of theater in Indonesia.

and Turks create colored shadows on the screen by dyeing the leather figures. In Indonesia, a popular form of puppet theater called *wayang kulit* (leather shadow puppets) presents plays based on Hindu myths. The performances begin in the early evening and last until dawn. See **Indonesia** (The arts).

Dummies are puppets that play an important part in ventriloquism. The ventriloquist pretends to talk to the dummy, which is held on the knee or on a chair. The ventriloquist "throws" his or her voice so that the dummy seems to be speaking. Rods and strings inside the puppet enable the ventriloquist to move the puppet's head and parts of its face from the back. See **Ventriloquism** (picture).

Organizations for puppeteers help people improve their technique with puppets. The Puppeteers of America has members in the United States, Canada, and about 20 other countries. The Union Internationale des Marionettes (UNIMA) is another international organization of puppeteers. The headquarters of UNIMA are in Warsaw, Poland, and the organization has national chapters in the United States, Canada, and about 15 other countries. Puppet centers have been established in Atlanta, Georgia; Boston; Toronto, Canada; and London. Their puppet exhibitions and performances by leading puppeteers provide exposure to the art of puppetry.

Kenneth B. McKay

See also **Animation** (Puppet animation).

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Lade, Roger. *The Most Excellent Book of How to Be a Puppeteer.* Copper Beech, 1996. Younger readers.

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Puppy. See **Dog** (Caring for a dog).

How to make a hand puppet





To make the face, the girl uses common materials found in the home. She first glues on an eye made of felt to the end of a white sock, *left.* The sock serves as the puppet's head and body. She then sews on eyelashes made of yarn, *right.*





To complete the head, the girl adds hair by sewing long strands of yarn onto the sock, *left.* She draws the puppet's mouth with ink, *right.* She also used ink to draw the eyebrows. She can add other decorations to the head and body.



WORLD BOOK photos

Two hand puppets perform on a box that serves as a stage. The puppet on the left consists of a head and body made from paper bags and decorated with colored paper, straws, and yarn.

Purcell, *pur SEHL,* **Edward Mills** (1912-1997), an American physicist, shared the 1952 Nobel Prize for physics. He received the award for developing and applying a simple but precise method for determining the magnetic properties of nuclei. Purcell also made important contributions to radio astronomy. In addition, Purcell served as an adviser to the United States government on science policy. He was born in Taylorville, Illinois. In 1949, he became a professor of physics at Harvard University. Robert H. March

Purcell, *PUR suhl,* **Henry** (1659?-1695), was an English composer during the baroque period. He wrote religious music, as well as music for the theater and ceremonial music for the English court. Purcell is admired for his original harmonies and for his skillful setting of the English language in his choral music. Purcell was aware of musical developments in other countries. His trio sonatas and many of his songs for the theater are modeled on the Italian style. Some of his religious anthems imitate French fashions.

Purcell wrote one of the earliest English operas, *Dido and Aeneas* (1689). It contains a famous song, "When I am laid in earth" ("Dido's Lament"), composed in one of Purcell's favorite forms, called *ground bass.* This form uses a short melodic theme in the bass part repeated over and over with changing harmonies.

Purcell was born in London. As a boy, he sang in the choir of the Chapel Royal, the king's private chapel. In 1679, Purcell was organist of Westminster Abbey, and in 1682 he became an organist of the Chapel Royal.

Joscelyn Godwin

Purchasing power. See **Inflation** (introduction).

Purdue University is a publicly controlled coeducational land-grant school. Its main campus is in West Lafayette, Indiana. The university also has regional campuses in Fort Wayne, Hammond, and Westville. Purdue operates the Fort Wayne campus jointly with Indiana University. Both universities also offer courses at Indiana University-Purdue University at Indianapolis (see **Indiana University**). Purdue is supported by the state of Indiana, but it also receives aid from the federal government and various private sources.

Purdue is well known for its engineering programs, having schools of chemical, civil, electrical, industrial, materials, and mechanical engineering. Purdue also has a school of aeronautics and astronautics, and departments of agricultural and nuclear engineering. In addition, there are schools of agriculture; consumer and family sciences; education; liberal arts; management; pharmacy and pharmacal sciences; science; technology; and veterinary medicine. Purdue also has a graduate school and a research foundation. Courses at the university lead to associate, bachelor's, master's, and doctor's degrees.

Purdue's Hall of Music is the largest college auditorium in the United States, seating over 6,000 people. The Ross-Ade stadium is named in honor of two Purdue graduates—David Ross, an inventor and manufacturer, and George Ade, an author and humorist. Purdue was founded in 1869 and is named for John Purdue, one of the university's earliest benefactors.

Critically reviewed by Purdue University



Purdue University

Purdue's main campus is located in West Lafayette, Indiana. The university is noted for its engineering programs. Purdue's enrollment is one of the largest in the United States.

Pure food and drug laws establish health and safety standards for foods, drugs, medical devices, and cosmetics. The basic food and drug law of the United States is the Federal Food, Drug, and Cosmetic Act. This act, which was passed in 1938, prohibits the distribution of impure foods, drugs, or cosmetics in the United States. It also forbids false or misleading labeling on such products.

The Food and Drug Administration (FDA)—an agency in the Department of Health and Human Services—enforces the Federal Food, Drug, and Cosmetic Act. The FDA checks food and drug products to make certain they meet federal standards. If the FDA finds evidence of violations, it gives the evidence to a federal court. Federal courts receive several hundred new cases annually that deal with such violations.

Foods

A major section of the Federal Food, Drug, and Cosmetic Act gives the FDA power to set standards for both human and animal foods. Food standards define what ingredients a food must contain and how the food should be labeled. The FDA sets standards for only the most common food products. The food section of the federal act contains provisions that cover (1) impurities in foods, (2) food additives, and (3) labeling of foods.

Impure foods are foods that do not meet the safety, purity, or cleanliness standards of the Federal Food, Drug, and Cosmetic Act. They include foods that have dirty or rotten contents or have been prepared or packaged under unsanitary conditions. The most frequent sources of impurities found in food are insects, mice, and rats.

In addition, harmful chemicals may be the cause of impurities. Such chemicals may be present in food on which producers have used a poisonous spray. Harmful chemicals also may be found in fish that have lived in polluted water.

Food additives are substances that food producers can legally add to their products. They include spices and many other substances used to flavor or preserve food. The Federal Food, Drug, and Cosmetic Act requires that these substances be proved safe by scientific tests before they are put on the market. About 2,800 food additives have been approved. Permitted additions to foods also include color additives. The FDA must ap-



Centers for Disease Control and Prevention

Pure food and drug laws protect consumers from impure and unsafe food and drugs. In the United States, the Food and Drug Administration (FDA) enforces such laws. This FDA technician is testing for a disease spread by contaminated food and water.

prove every batch of color that is used in the preparation of foods, drugs, and cosmetics.

The safe use of pesticides is also permitted. Food growers often use pesticides on or around food. The Environmental Protection Agency determines how much pesticide may remain on a food crop. It sets these levels far below those that would make the food dangerous to eat. The FDA tests food products for pesticide and takes them off the market if too much remains on them.

Labeling of foods. The Federal Food, Drug, and Cosmetic Act requires food producers to provide certain information on the labels of their products. This information includes the name of the product and of its manufacturer, packer, or distributor; the amount of food in the package or container; a complete list of ingredients, except for some standardized foods; and the name of any chemical substance added. In addition, a food label must tell if artificial color or flavor has been used, except for some colors that are added to butter, cheese, and ice cream. The Nutrition Labeling and Education Act of 1990 requires that all packaged and processed foods sold in the United States also carry labels with nutritional information (see Nutrition [Nutrition guidelines]).

Drugs and devices

The Federal Food, Drug, and Cosmetic Act defines drugs as products intended for use in the medical care of people or animals. The act covers several kinds of drugs, including (1) prescription drugs, (2) over-the-counter drugs, (3) biological drugs. It also covers medical and other devices.

Before a producer can sell a new drug, the drug must be tested thoroughly to find out if it is safe and effective when used as directed. The producer must give the FDA a report on all tests and on all the ingredients of the drug and the methods for testing their strength and purity. The producer must submit the proposed label directions and any needed warnings. The FDA, after approving a new drug, keeps watch on its use and effects.

Prescription drugs are dangerous to use except under medical supervision. The Federal Food, Drug, and Cosmetic Act defines the kinds of drugs that should be in this group. The act forbids the sale of such drugs unless a physician or a dentist has prescribed them. The act also prohibits the sale of a prescription drug for an animal unless a veterinarian has prescribed it.

Over-the-counter drugs may be sold without a prescription. Such drugs must be safe for use without medical supervision. Label directions and warnings on over-the-counter drugs must be clear and easily seen, so that consumers can use the drugs safely and effectively.

Biological drugs are made from animal or human substances. These drugs include serums and vaccines, and drug products made from human blood. A manufacturer may not sell such a drug unless the FDA has licensed it. An FDA license assures the purity, safety, and strength of the drug.

Devices. Medical devices are products used in the control or treatment of disease. The Federal Food, Drug, and Cosmetic Act requires them to be safe and effective. Such devices include artificial parts for the human body, fever thermometers, and sun lamps. Many medical devices need FDA approval before they go on the market. The FDA also tests radiation-emitting devices such as X-ray machines, televisions, and microwave ovens to ensure that they do not endanger health.

Cosmetics

Cosmetics include such products as deodorants, lipsticks, perfumes, shampoos, and toothpaste. The Federal Food, Drug, and Cosmetic Act requires cosmetics to be safe and properly labeled. It also requires cosmetic producers to make and package their products under sanitary conditions. The ingredients used in a cosmetic must be listed on the label. The labels must include the manufacturer's name and address. Labels of coal tar hair dyes must warn that the product should be tested for possible skin irritation before being used.

Enforcement

The Food and Drug Administration publishes regulations that explain the Federal Food, Drug, and Cosmetic Act. However, manufacturers sometimes violate the act, accidentally or intentionally. In most cases, the FDA does not prosecute if the manufacturer voluntarily stops

shipping an illegal product. If an illegal product has already been sold, the manufacturer may be required to notify the people who bought it and arrange to take the unsold stocks of the product off the market. This procedure is called a *recall.*

Evidence of violations of the act is gathered by about 1,100 field investigators and inspectors. These FDA employees inspect factories and warehouses and investigate complaints of illness or injury caused by impure or mislabeled foods, drugs, or cosmetics. In addition, FDA inspectors supervise the enforcement of court rulings on violations.

The FDA also employs about 925 scientists in field jobs, including microbiologists, chemists, and veterinarians. These experts use laboratory tests to check the purity, safety, and effectiveness of foods, drugs, cosmetics, and devices. The FDA employs hundreds of other scientists and physicians who review and approve new drugs and serve as experts in other scientific areas.

Three kinds of legal action can be taken if the FDA finds that a producer has violated the federal food and drug laws: (1) A federal court may issue an *injunction* (court order) directing the manufacturer to stop. (2) The court, acting on evidence from the FDA, may seize a product that violates the law. (3) Prosecution for such violations can result in a fine or imprisonment or both.

History

Since ancient times, there have been food and drug laws regulating the quality of meat, milk, and flour products. By about A.D. 1300, European merchants had set up powerful trade organizations to inspect food and drugs. During the Industrial Revolution, which occurred in the 1700's and early 1800's, food producers began using chemicals to preserve and color food.

In 1784, Massachusetts passed the first general pure food and drug law in the United States. Early state laws were difficult to enforce, however, because they often did not define *pure,* and what was considered pure in one state could be ruled impure in another. Also, some people felt it was unfair to punish a merchant for selling foods or drugs that the merchant did not know were considered impure in a particular state.

In 1848, Congress passed the first federal drug law, the Import Drug Act, to stop drugs of poor quality from coming into the country. Beginning in 1883, Harvey W. Wiley, chief of the Bureau of Chemistry in the U.S. Department of Agriculture, began studies of food purity. He favored passage of a federal law that would define impure and misnamed foods and drugs for all states. Public support for passage of such a law grew as journalists wrote about certain chemical preservatives and other harmful substances in foods and about dangerous ingredients, such as alcohol and opium, in drugs. As a result, Congress passed two food and drug acts in 1906—the Meat Inspection Act and the federal Food and Drugs Act. Stronger legislation—the Federal Food, Drug, and Cosmetic Act—was passed in 1938. The act has been revised many times since then.

Food and drug laws in Canada

Parliament passed Canada's first food and drug law in 1875. Today, the nation's main food and drug law is based on the Canadian Food and Drugs Act of 1920. Other important Canadian food and drug acts include the Narcotic Control Act and the Proprietary or Patent Medicine Act.

The Canadian food and drug acts prohibit the production or sale of impure food and drug products. Like the United States laws, these acts set standards of purity and safety for foods, drugs, cosmetics, and medical devices. The acts are enforced by the Health Protection Branch of the Department of National Health and Welfare.

In 1995, the FDA declared that nicotine was a drug and that cigarettes and other tobacco products were nicotine "delivery devices." As a result, the FDA introduced restrictions on the marketing and sale of tobacco products to young people. In 2000, however, the Supreme Court of the United States ruled that the FDA does not have the authority to regulate tobacco products. Critically reviewed by the Food and Drug Administration

Related articles in *World Book* include:

Adams, Samuel Hopkins
Drug (Drug regulation)
Food (Government regulations)
Food additive
Food and Drug Administration
Meat packing (U.S. government inspection)
Nutrition (Illustration: Food labels)
Sinclair, Upton

Purgatory, *PUR guh TAWR ee,* is a state, according to Roman Catholic tradition, in which people who have died atone for their sins before being admitted to the vision of God in heaven. In purgatory, those who have been in the friendship of God make full amends for their failings by suffering. People can reduce their future suffering by engaging in various religious or pious acts before death. Those who are already in purgatory can be helped by the prayers of the living. Joseph M. Hallman

Purim, *PU rihm* or *poo REEM,* is a joyous Jewish festival celebrated in February or March, on the 14th day of the Hebrew month of Adar. It commemorates the rescue of the Jews of Persia from a plot to kill them.

The story of Purim is told in the Book of Esther in the Bible. Esther was the beautiful Jewish queen of King Ahasuerus of Persia. Her uncle Mordecai advised her, however, not to reveal that she was Jewish. The king's wicked minister, Haman, persuaded Ahasuerus to have all the Jews in the empire killed. Haman drew lots to determine the day of their execution. The word *Purim* comes from the Hebrew word *pur,* which means *lot.* Mordecai and Esther decided to tell the king that Esther was Jewish and to plead with him to spare her people from destruction. First Esther fasted in preparation for her visit to the king, and then she revealed her Jewish origins. Ahasuerus was angry with Haman and had him killed for his plot. He then appointed Mordecai as minister.

Jews celebrate the survival of their people with great merriment. The Book of Esther, called the Megillah, is read in the synagogue. People send gifts of food to their neighbors and give charity to the poor. People dress in costumes representing Esther, Mordecai, Haman, and Ahasuerus, and hold carnivals. Jewish tradition established the Fast of Esther on the day before Purim to commemorate Esther's fast and her courageous deeds (see **Esther, Book of**). Lawrence H. Schiffman

Puritans, *PYUR uh tuhnz,* were members of a religious and social movement of the 1500's and the 1600's. The

movement began in England and spread to America where it greatly influenced social, political, and religious institutions. Such religious denominations as Congregationalism and Unitarianism developed from Puritan beliefs.

Puritan beliefs developed from the teachings of religious reformers, such as John Wycliffe and John Calvin. Wycliffe was a famous professor of philosophy at Oxford University during the 1300's. Calvin was a leader of the *Reformation,* the religious movement of the 1500's that gave rise to Protestantism.

The Puritans considered the Bible as the true law of God that provided guidelines for church government. They wished to shape the Church of England to meet their ideals. They called for a less priestly church that emphasized preaching. Puritans believed that all Christian churches should be organized through councils called *presbyteries* or *church courts* rather than under bishops, as in the Church of England. Some Puritans believed that each congregation was a complete church in itself and should have total control of its own affairs.

The Puritans emphasized Bible reading, prayer, and preaching in worship services. They simplified the ritual of the sacraments. They also wanted more personal and fewer prescribed prayers. The Puritans stressed grace, devotion, prayer, and self-examination to achieve religious virtue.

History. The term Puritan was first used in the late 1500's to identify a party within the Church of England, the national church. The party sought to make further changes in the church than had been brought about by Protestant reforms during the reigns of King Henry VIII, King Edward VI, and Queen Elizabeth I. Defenders of these reforms called the party members Puritans because of their proposals to "purify" the church.

As early as the 1520's, English Protestant leaders had demanded reforms along the lines that were later called Puritan. In the 1520's and 1530's, William Tyndale published pamphlets and English translations of the Old Testament and New Testament designed to encourage such reforms. Hugh Latimer, who became an important Protestant bishop, also had raised such protests to purify the church.

Many English Christians agreed with the demands of Tyndale and Latimer that the church and the government be operated according to the Bible. These Christians believed that the Bible governed all human affairs. John Wycliffe had taught this doctrine at Oxford in the 1300's. Under King Edward VI and Queen Elizabeth I, these teachings received support from English clergymen who followed Calvin's doctrine that the New Testament described how the church should be run.

During the 1600's, the Puritans increasingly opposed the political and religious policies of the Stuart rulers, King James I and his son, King Charles I. In 1604, James I called the Hampton Court Conference to settle disagreements within the Church of England. However, James refused to bring about the reforms the Puritans sought, except for a new translation of the Bible, now called the King James Version.

The Puritans gained in strength in Parliament, and repeatedly introduced legislation against the Crown's policies. In 1642, civil war broke out between the Crown forces, called *Royalists* or *Cavaliers,* and the Puritans, called *Roundheads.* They received this name because they cut their hair short. This English Civil War is also called the *Puritan Revolution.*

The Puritans, led by Oliver Cromwell, won a series of victories and took control of the government in 1649. The Puritans closed theaters and passed other unpopular measures. Their political power ended after Cromwell died in 1658. In 1660, the Stuart dynasty returned to the throne.

Political aspects of the Puritan movement lived on in the policies of the Whig Party in England. Puritan religious ideals were revived in the rise of the Methodist Church in the 1700's.

During the 1600's, some Puritan groups believed that

Library of Congress

Puritan settlers fought off Indian attacks in Salem, Massachusetts Bay Colony. The soldier nails a board that will secure the door. The man at the window protects the children from danger. His son stands ready with a musket.

reform of the Church of England was impossible and departed to settle in North America. They founded settlements in Virginia and along New England's coast, especially in Massachusetts Bay Colony and Connecticut.

The Puritans shaped religion, social life, and government in North America to their ideals. Their strong belief in education led them to establish Harvard and Yale as colleges and to require a system of grammar schools in the colonies. The Puritans organized their government according to the teachings that they found in the Bible and on the basis of their English experience.

Late in the 1500's, some Puritans separated from the Church of England and set up their own congregations. Such groups were called *Separatists.* A group of English Separatists first went to Holland and then founded Plymouth Colony in what is now Massachusetts in 1620. This group of Puritans is better known as *Pilgrims.* Some Separatists moved to Rhode Island and became Baptists. Others joined the Massachusetts Bay Puritans and became Congregationalists. Thus, while the Puritan movement in England died down, it influenced Protestant denominations in England and America.

Puritan influence also shaped political and social institutions in England and the American Colonies. In England, the Puritan Revolution led to a greater emphasis on *limited* or *constitutional monarchy,* in which a constitution, legislature, or both limit the power of a ruler. The Puritans' belief in government by contract from the governed influenced the development of American democratic principles.

Over time, the term *puritan* has broadened to mean a strictness in morals or religious matters. The term is commonly applied to cultural traits found in the literature of, and social attitudes shared by, the New England Colonies. Such traits include an emphasis on education and the glorification of hard work.

The word puritan has also been used to describe reforming attitudes and activities that were not part of the culture of the Puritans. For example, *prohibition,* the forbidding of the sale or manufacture of alcoholic beverages, and *temperance,* the avoidance of alcohol, are often called puritan movements. But the Puritans did not disapprove of the use of alcohol. In addition, the term puritan has come to describe the moral attitudes and values that characterize modern movements for rapid social change that require discipline and hard work.

Many social scientists have studied the role of the Puritans in the development of modern social patterns. The German sociologist Max Weber associated the Puritan belief in hard work with the rise of the free enterprise system. Others emphasize the connection between the behaviors and beliefs of the Puritans and those of modern revolutionaries. John F. Wilson

Related articles in World Book include:

American literature (New England)
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Defoe, Daniel (His writings)
Laud, William
Literature for children (The Puritans)
Massachusetts (The Puritans)
Massachusetts Bay Colony
Pilgrims
Plymouth Colony
Protestantism (The free church movements)
Wycliffe, John

Additional resources

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Purslane, *PURS layn,* is a matting annual weed. It is one of the worst pests in American gardens and cultivated fields. The plant covers a sizable area and is also a home for insects that feed on corn and melons. It has thick, fleshy leaves and stems, and yellow flowers. The purslane bears many seeds, and it is important to destroy the plant before the seeds ripen. Young shoots are sometimes eaten in salads.



Grant Heilman

Purslane

Harold D. Coble

Scientific classification. Purslanes belong to the purslane family, Portulacaceae. Purslane is *Portulaca oleracea.*

Pus. See Abscess.

Pusan, *poo sahn* (pop. 3,798,113), is the second largest city and the major port in South Korea. Only Seoul has more people. Pusan lies on the southeast coast of the Korean Peninsula. For location, see **Korea** (political map).

Pusan's harbor can accommodate about 80 large ships at a time, and the city's port handles millions of tons of cargo yearly. The city is an important center of South Korea's fishing industry. Pusan is also an administrative, commercial, and industrial center. The large number of industries located in and near the city produce chemicals, electric and electronic equipment, machinery, plywood, rubber goods, ships, and textiles. Pusan has an underground rapid-transit system and an international airport.

Pusan is also a tourist center. The region's beaches and hot springs attract many visitors. Two religious landmarks in the Pusan area also attract visitors. Tongdosa and Pomosa are both large, beautiful Buddhist temple-monastery complexes of buildings that lie on the slopes of wooded hills. The United Nations Cemetery is near Pusan. It contains the graves of armed forces personnel from nations that fought as allies in the Korean War (1950-1953).

Pusan dates from ancient times. During the Korean War, it served as the temporary capital of South Korea and was the chief landing and supply port of the United Nations forces. Pusan's population has increased sharply since the war. Today, the city suffers from a shortage of housing. Chong-Sik Lee

See also **Asia** (picture: A fish market).

PUSH. See **Jackson, Jesse Louis.**

Pushkin, Alexander (1799-1837), is considered Russia's greatest poet and, by many, the greatest Russian writer of any kind. He is known as the father of Russian literature and modern Russian literary language.

His works. Pushkin wrote in a wide variety of poetic and prose styles. He first achieved fame for long, narra-

tive poems similar to those of the English poet Lord Byron, but he was also a master of lyric poetry and wrote plays in verse. In the late 1820's, he turned to prose and produced a series of outstanding short stories, novellas, and novels. He was also a brilliant literary critic, letter writer, and historian. In addition to his unparalleled influence on Russian literature, Pushkin's works provided subjects and inspiration for Russia's leading artists, composers, and *choreographers* (dance composers).

Pushkin's most famous work is *Eugene Onegin* (1825-1832), a novel in verse. The title character is intelligent, good-hearted, and liberal but lacks moral discipline and a serious occupation or purpose in life. As a result, he destroys himself and those around him. Much of the story deals with Onegin's relationship with a beautiful country girl named Tatyana. These figures, the weak Eugene and the sincere Tatyana, became models for characters in later Russian literature.

Pushkin's drama *Boris Godunov* (written in 1825, published in 1831), written in blank verse, introduced Shakespearean historical tragedy to the Russian stage. The play tells the story of the guilt of Czar Boris, who, Pushkin believed, had ascended to the throne by murdering the rightful heir, the infant Dmitriy. In 1830, Pushkin also wrote four "little tragedies" in verse, which were not intended for staging. The most famous are "The Stone Guest" and "Mozart and Salieri."

Pushkin wrote lyric poems about love, nature, and the obligations of poetry and the poet in Russia. His five prose stories, the *Tales of Belkin* (written in 1830), differ from the conventional romantic prose of his time in their realism. "The Queen of Spades" (1834) is perhaps his most popular short story.

His life. Alexander Sergeyevich Pushkin was born in Moscow. One of his great-grandfathers was a black Ethiopian courtier to the Russian ruler Peter the Great. Pushkin took great pride in his black ancestry and noble heritage. Even as a student, Pushkin was viewed as the great poetic genius of the nation.

The czar's secret police began to watch Pushkin after he wrote the ode "Liberty" and several poems that criticized important government officials. In 1820, he was exiled first to southern Russia and later to his family estate, called Mikhailovskoye near Pskov. In 1826, a new czar, Nicholas I, called Pushkin to St. Petersburg and gave him a pardon. For the rest of his life, Pushkin combined writing with historical research, particularly on the reign of Czar Peter I. His greatest narrative poem, *The Bronze Horseman* (1833), deals with that period.

In 1831, Pushkin married Natalya Goncharova, a beautiful woman in St. Petersburg society. She acquired numerous male admirers at court. Easily made jealous, Pushkin challenged one of the admirers to a duel in January 1837 and was mortally wounded. The entire Russian intellectual community perceived his early death as a national tragedy. Pushkin's death is the subject of great poems by several Russian writers. Anna Lisa Crone

See also **Russian literature** (Early romanticism); **Opera** *(Boris Godunov)*.

Pushtuns. See Pashtuns.

Pussy willow is a shrub or small tree of the willow family. It grows wild in eastern North America from Nova Scotia south to Virginia and west to Missouri. Pussy willows grow best in moist places, but they also can be found on dry soils. They seldom grow taller than 20 feet (6 meters). They have several long, straight twigs without side branches. The twigs have many flower buds.

In early spring, before the leaves unfold, the flower clusters break out of the hard buds. These clusters are called *catkins*. Male and female catkins grow on sepa-



Grant Heilman

Pussy willow flowers appear in spring. At first, the flower clusters have a coat of silky, grayish-white hair. The male clusters later develop into loose masses covered with yellow pollen.

rate trees. The catkins are long, round, and covered with a dense coat of silky, grayish-white hair. They have been said to resemble tiny kittens climbing up the twig. Later the male catkins develop into larger, loose masses covered with yellow pollen. Richard C. Schlesinger

Scientific classification. The pussy willow belongs to the willow family, Salicaceae. Its scientific name is *Salix discolor*. Several other species of willow with silky catkins are also known as pussy willows.

See also **Catkin**; **Willow**.

Putin, *POO tihn,* **Vladimir Vladimirovich,** *VLAH duh meer VLAH duh MEER uh vihch* (1952-), is the president of Russia. He worked to strengthen the federal government and to reign in local government officials and powerful business interests. Under Putin's leadership, Russia developed friendlier relations with Europe and the United States.

In 2002, Russia entered into a special partnership with the North Atlantic Treaty Organization (NATO), a military alliance originally formed to oppose the Soviet Union. A new NATO-Russia Council allows Russia to work more closely with NATO members on various security issues. That same year, Putin and United States President George W. Bush signed a treaty to reduce the number of nuclear weapons in both countries.

Putin was born in Leningrad (now St. Petersburg). He earned a law degree from Leningrad State University in 1975. Putin served in the KGB, the intelligence-gathering and security force of the Soviet Union, from 1975 to 1990.



AP/Wide World

Vladimir Putin

In 1990, Putin returned to Leningrad and worked in the city's government. In 1996, he was invited to Moscow to serve in Russia's federal government. In 1997, Putin earned an advanced degree in economics from St. Petersburg State Mining Institute.

Putin advanced within President Boris N. Yeltsin's administration, holding a variety of positions. In 1998, he was named head of the Federal Security Service, a successor to the KGB. In August 1999, Yeltsin chose Putin as prime minister. Putin became acting president of Russia on Dec. 31, 1999, after Yeltsin resigned. Putin was elected president by the people of Russia in March 2000.

Stuart D. Goldman

Putnam, Herbert (1861-1955), an American librarian, was librarian of Congress longer than any other person who ever held the position. Appointed by President William McKinley in 1899, he served until he retired in 1939. He was the first experienced professional librarian to become librarian of Congress. Before his appointment, he held posts as librarian of the Boston Public Library and president of the American Library Association.

During the late 1800's, the Library of Congress began to develop beyond its original purpose as a legislative reference library and become a national institution. Putnam oversaw several important milestones in this development. He felt strongly that the library should serve the American people and focused many of his efforts on creating programs to encourage widespread public use. For example, under Putnam's leadership, scientific investigators and other qualified individuals gained access to the library's vast collections. He also began an extensive interlibrary loan service that made materials in the collections available to local institutions. Putnam was born in New York City. Gregory Allan Finnegan

See also **Library of Congress**.

Putnam, Israel (1718-1790), an American patriot, was a general in the Revolutionary War in America (1775-1783). One of the few experienced soldiers at the war's start, he rose from the rank of second lieutenant to lieutenant colonel in the French and Indian War (1754-1763). He became a major general in the Continental Army.

During the difficult years before the war, Putnam was a stout opponent of the British government. He became a leader in the Sons of Liberty and served as chairman of the Brooklyn (Connecticut) Committee of Correspondence. When Putnam heard about the Battle of Lexington, he hurried to Cambridge and joined the colonial soldiers. Later, he fought in the Battle of Bunker Hill.

Putnam was born in Salem Village (now Danvers), Massachusetts. During the French and Indian War, the Indians captured him, but he escaped from death through a dramatic rescue. In 1762, Putnam led a Connecticut regiment in an unsuccessful expedition against the French in the West Indies. James H. Hutson

Putnam, Rufus (1738-1824), an American general in the Revolutionary War in America (1775-1783), became known as the founder and father of Ohio. Putnam and others organized the Ohio Company in 1786 to colonize the territory located northwest of the Ohio River. Putnam was in charge of the first colony of settlers, and, in 1788, he established the first permanent white settlement at Marietta, Ohio.

Putnam was born in Sutton, Massachusetts. He served three years as a soldier in the French and Indian War (1754-1763). In 1761, he settled in North Brookfield, Massachusetts, and worked as a millwright and surveyor. Putnam became a lieutenant colonel in the Continental Army when the Revolutionary War began. He planned and built the fortifications around Boston so well that, in 1776, he was appointed chief engineer of the army, with the rank of colonel. Putnam served in many engagements, and he became a brigadier general in 1783. In March 1790, Putnam was appointed a judge of the Northwest Territory. In 1796, he became surveyor general of the United States. Richard J. Hopkins

See also **Ohio Company**.

Putrajaya, *poo trah JAH yah* (pop. 7,000), is a new city being built to serve as Malaysia's administrative capital. The city did not exist before the government planned and built it. Construction began in 1995. Besides government offices, Putrajaya features residential areas, botanical gardens, parks, and wetlands. It lies about 20 miles (32 kilometers) south of Malaysia's capital, Kuala Lumpur.

Putrajaya is part of a plan by Prime Minister Mahathir bin Mohamad to develop the high-technology sector of Malaysia's economy. The city stands in an area called the Multimedia Super Corridor (MSC), which extends south from Kuala Lumpur to Kuala Lumpur International Airport at Sepang. The MSC is being developed to include cities, high-technology office parks, and suburbs, all connected by expressways, a rapid transit rail system, and advanced communications. Plans call for the neighboring city of Cyberjaya to have computer software companies, research and development firms, and a university. Brian J. Shaw

Putty is a filler material that is soft when applied but slowly hardens. It is used to fill knotholes, cracks, and other defects in wood surfaces before the surfaces are painted. Putty is also placed around the edges of panes of glass to seal them in a window sash or door.

The most common putty is a mixture of powdered natural chalk, called *whiting,* and linseed oil, to which a small proportion of coloring agents may be added. Putty hardens because some of the oil combines with oxygen from the air and the rest of the oil soaks into the wood.

Some projects require special, more elastic putty. This type of putty is made from vegetable oil, nondrying oils, driers that make the putty harden, synthetic fibers, a powdered limestone filler, and a coloring agent.

James S. Reed

Puzo, Mario (1920-1999), was an American novelist and screenwriter best known for his novel *The Godfather* (1969). The novel portrays a New York City family involved in organized crime. The narrative describes the family's fight for power against other underworld families in the United States.

The film adaptation of *The Godfather* in 1972 became one of the most popular and acclaimed movies in history. Puzo shared an Academy Award with director Francis Ford Coppola for his screenplay for the film. He again won an Academy Award as coauthor with Coppola of the screenplay for the sequel, *The Godfather, Part II* (1974). Puzo co-wrote the screenplay with Coppola for the third film in the series, *The Godfather, Part III* (1990). He also helped write the screenplays for the films *Earthquake* (1974), *Superman* (1978), and *Superman II* (1980).

Puzo was born in New York City. His first novel was *The Dark Arena* (1955). His other novels include *The For-*

tunate Pilgrim (1964), *Fools Die* (1978), *The Sicilian* (1984), and *The Fourth K* (1991). *The Last Don* (1996) and *Omerta* (published in 2000, after Puzo's death) return to the subject matter of *The Godfather.* Jon L. Breen

PVC. See **Polyvinyl chloride.**

PX. See **Post exchange.**

Pygmalion, *pihg MAY lee uhn,* was a sculptor and king of Cyprus in Greek legend. Disgusted by the wicked women of his day, Pygmalion carved an ivory statue of a beautiful woman and then fell in love with it. In answer to his prayer, the goddess Aphrodite made the statue a living woman. Pygmalion married her, and they had a son named Paphos.

The legend of Pygmalion has attracted many writers. The ancient Roman poet Ovid retold the story in his collection of tales called *Metamorphoses.* The best-known modern version of the story appears in George Bernard Shaw's play *Pygmalion* (1913). The play tells how an Englishman makes an elegant lady out of an ignorant girl by teaching her to act and speak correctly. The musical comedy *My Fair Lady* (1956) was based on Shaw's play.

Jon D. Mikalson

Pygmies, *PIHG meez,* are small people. The word *pygmy* is a general term for anything small. When spelled with a capital *P*, it usually refers to a member of one of several groups of African people. Most adults who belong to these groups are from 4 feet to 4 feet 8 inches (1.2 to 1.42 meters) tall. This article tells about African Pygmies. Other Pygmies, called *Negritos,* live in parts of Asia and on some islands of the Indian and Pacific oceans (see **Negritos**).

African Pygmies live in thick tropical rain forests. Most live in central Africa, in parts of Burundi, Cameroon, the Central African Republic, Congo (Brazzaville), Congo (Kinshasa), Equatorial Guinea, Gabon, Rwanda, and Uganda. Many scholars believe they once made their homes throughout central Africa. Peoples who speak Bantu languages invaded much Pygmy territory and cut down the forest to grow farm crops and to set up villages.

Today, the Pygmies continue to lose territory because of the construction of roads and towns in the forests where they live. Together, the Pygmy groups have a population of approximately 150,000. In recent decades, the number of Pygmies who follow their traditional way of life has declined at a rapid rate.



Nadine Peacock, Anthro-Photo

Pygmy dancers perform in a small clearing carved out of the dense jungle. Each African tribe has its own symbolic and traditional dances that are passed on from generation to generation.

Way of life. Pygmies have traditionally lived by hunting and gathering. The men hunt antelope, birds, elephants, monkeys, and other animals. Most of the hunters trap animals in large nets and kill them with spears. Some Pygmies hunt with small bows and poisoned arrows. The women gather berries, mushrooms, nuts, and roots. Pygmies also like to eat honey.

Some Pygmies live in small bands of fewer than 50 members. Each band has its own territory in the forest. Pygmies establish temporary camps in clearings, and they build huts of saplings and leaves. A band moves its camp to a new area of the forest when the food supply runs low.

A Pygmy band has no formal leadership. Members of each band make decisions and solve problems by general discussion. Most Pygmies marry people of other bands. Ties of family and friendship link various bands, and a family may leave its band to join another one at any time.

Pygmies speak the same Bantu languages as their crop-growing neighbors. They trade meat to these neighbors for knives and other metal tools and for such agricultural products as bananas, corn, and rice.

Pygmies see the forest as the giver of all life. It provides them with clothing, food, and shelter. In return, Pygmies try not to harm the forest. They perform various ceremonies to maintain friendly relations with the natural and supernatural worlds. Wade C. Pendleton

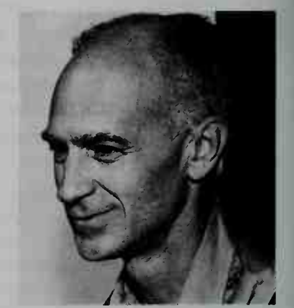
See also **Africa** (Peoples of Africa; picture: Congolese Pygmy).

Additional resources

Siy, Alexandra. *The Efe: People of the Ituri Rain Forest.* Dillon Pr., 1993. Younger readers.
Wheeler, William F. *Efe Pygmies.* Rizzoli, 1999.

Pygmy chimpanzee. See **Bonobo.**

Pyle, Ernie (1900-1945), an American newspaperman, won a Pulitzer Prize in 1944 for his reporting. His syndicated columns during World War II told millions of Americans how their boys lived and fought as soldiers. Writing with humor and sensitivity, Pyle became one of the best-loved reporters in the United States. He traveled with U.S. troops on nearly every front in Africa and Europe before he went to the Pacific war theater. A Japanese machine-gunner killed him on April 18, 1945, on Ii Shima island during the battle for Okinawa.



UPI/Bettmann Newsphoto

Ernie Pyle

Ernest Taylor Pyle was born on Aug. 3, 1900, near Dana, Indiana. He studied at Indiana University. Pyle worked on newspapers in Indiana, Washington, D.C., and New York City before he became a columnist in 1935. Columns he wrote during the war were published as *Ernie Pyle in England, Here Is Your War,* and *Brave Men.* William McKeen

Pyle, Howard (1853-1911), an American painter, became one of the most influential illustrators of his time.

As an art teacher, he helped develop the talents of such American artists as Maxfield Parrish and N. C. Wyeth.

Pyle combined vigorous draftsmanship with a rich imagination. His sense of pictorial design and his firm, expressive style of drawing has been compared with that of the German Renaissance artist Albrecht Dürer. Pyle's energy and creativity enriched the tradition of American illustration.

The books that Pyle wrote and illustrated continue to attract young readers. They include *The Merry Adventures of Robin Hood* (1883), *Pepper and Salt* (1886), *Twilight Land* (1895), and *The Story of King Arthur and His Knights* (1903). For many years, Pyle illustrated pages in *Harper's Monthly* and drew illustrations for books written by other authors.

Pyle was born on March 5, 1853, in Wilmington, Delaware, and studied at the Art Students League in New York City. He was an art teacher at Drexel Institute in Philadelphia. He died on Nov. 9, 1911.

Marilyn Fain Apseloff

Pyloric sphincter. See **Stomach** (The stomach's work).

Pym, John (1584-1643), an English leader in Parliament, opposed the attempts of King Charles I to rule England as an absolute monarch. Pym declared that "a parliament is that to the commonwealth, which the soul is to the body."

Pym became so influential in Parliament that his enemies nicknamed him *King Pym.* In January 1642, the king entered Parliament with 400 guards to arrest Pym and four others. However, Pym and the others had fled moments before the king and his guards arrived. When the English Civil War broke out in August 1642, Pym formed an alliance with Scotland, which sent troops to fight against the king.

Pym was born in Somerset, England. He entered Parliament in 1621. Pym died of cancer on Dec. 8, 1643, during the second year of the Civil War. Lacey Baldwin Smith

Pynchon, Thomas (1937-), is a leading American novelist noted for his dense style that makes extreme demands on the reader. The difficulty of his works is intensified by the mass of information he pours into his plots as well as shifting narrative points of view and highly technical language and science-based symbols.

Pynchon's reputation rests on only a few novels. Although they typically feature comic, even outrageous, episodes, the works are generally pessimistic in tone. The complex narratives portray modern society in chaos and heading toward destruction. Pynchon's characters often face huge evil conspiracies that may be real or fantasies. Pynchon made an immediate impact on the literary scene with his first novel, *V.* (1963). Among the novel's many plots is a character's search for a mysterious female known only as V. Pynchon's next novel, *The Crying of Lot 49* (1966), is a complicated story about a woman who tries to uncover a secret organization called "Tristero" and its underground communications system.

Many critics consider *Gravity's Rainbow* (1973) to be Pynchon's masterpiece. This huge novel takes place in London at the end of World War II in 1945 and in postwar Germany. It deals with an international conspiracy that dominates the world through missile technology.

Vineland (1990) is a novel set in the 1980's. The story reflects on the counterculture world of California during the 1960's and 1970's. *Mason & Dixon* (1997) is a parody of the English novel of the 1700's, though with many references to the modern day. The novel follows the adventures of the real-life English surveyors Charles Mason and Jeremiah Dixon as they map regions of North America during the 1760's. Pynchon's only other major work of fiction is a collection of short stories published as *Slow Learner* (1984).

Thomas Ruggles Pynchon, Jr., was born on May 8, 1937, in Glen Cove, New York. He graduated from Cornell University in 1959 with a B.A. degree. Pynchon is an intensely private person who refuses to provide biographical information about himself. He keeps his whereabouts secret from everyone but his closest friends. Arthur M. Saltzman

Pyongyang, *PYAWNG yang* (pop. 2,639,448), is the capital and largest city of North Korea. The city is also the cultural, economic, industrial, and military center of the country. Pyongyang lies in west-central North Korea, along the Taedong River. For the location of Pyongyang, see **Korea** (political map).

The North Korean Workers' (Communist) Party, which controls the national government, has its headquarters in Pyongyang. Party leaders in Pyongyang make all decisions affecting North Korea's political, cultural, economic, and social programs and see that they are carried out.

Modern apartment and office buildings line Pyongyang's wide avenues. Pyongyang is the home of Kim Il Sung University. One of the city's principal structures is the large government assembly building, which houses the Supreme People's Assembly, North Korea's legislature. The annual National Fine Arts Exhibition is held in Pyongyang.

Most of the people of Pyongyang work in govern-



© Hiroji Kubota, Magnum

Pyongyang is the capital and largest city of North Korea. The downtown area of the city includes traditional Korean architecture, *shown here,* as well as modern skyscrapers.

ment offices in the city or in the factories on the outskirts of the community. Factories in Pyongyang produce industrial goods, such as farm tractors and electric locomotives.

Pyongyang was founded about 3,000 years ago. It was the capital of ancient Korea. The Chinese invaded the city in 108 B.C. and ruled it until A.D. 313. After that, a series of small kingdoms controlled the Pyongyang area. In 427, Pyongyang became the capital of Koguryo, a Korean kingdom that also ruled part of southern Manchuria. Chinese armies destroyed Pyongyang in 668. However, the Korean kingdom of Koryo rebuilt the city during the 900's.

After World War II ended in 1945, Pyongyang served as the headquarters of the Soviet occupation army, which supported the Korean Communists. In 1945, Korea was divided into two parts. Two states, North Korea and South Korea, were established in 1948. Pyongyang became the capital of Communist North Korea. Much of the city was destroyed during the Korean War (1950-1953). However, the city was later rebuilt.

Chong-Sik Lee

Pyorrhea. See Periodontitis.

Pyramid, in geometry, is a solid figure with triangular faces that meet at a common point. The base of a pyramid is a *polygon,* a plane figure bounded by three or more sides. The number of faces in any pyramid equals the number of sides in its base. The point farthest from the base—at which the faces meet—is called the pyramid's *vertex.*

In a *regular pyramid,* the faces are all *congruent* (equal in size and shape). Such a pyramid has a base that is a *regular polygon*—that is, a polygon with all sides equal and all angles equal. A perpendicular line extended from the vertex of a regular pyramid meets the base at its center. Pictured here is a regular pentagonal pyramid. Its base is a regular five-sided figure called a *pentagon.*

The *altitude,* or height, of a pyramid is the distance along a perpendicular from the vertex to the base. The *volume (V)* of any pyramid may be found by using the following formula:

$$V = \frac{1}{3}Bh$$

In this formula, B stands for the area of the base and h for the height of the pyramid.

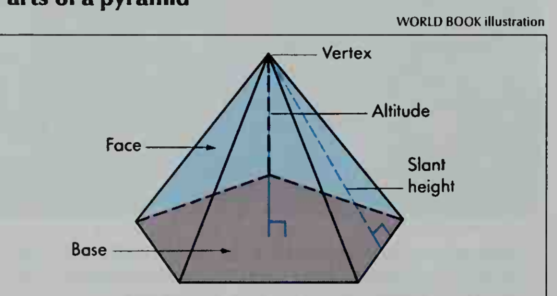
For a regular pyramid, the altitude of any face is called the *slant height.* The formula used to determine the area of the faces *(L)* of a regular pyramid is

$$L = \frac{1}{2}Ps$$

Here, P stands for the total length of the base's *perime-*

Parts of a pyramid

WORLD BOOK illustration



Some kinds of pyramids

WORLD BOOK illustrations

ter (outer boundary) and s for the slant height.

Arthur F. Coxford, Jr.

Pyramids are large structures with square bases and four smooth, triangular-shaped sides that come to a point at the top. Several ancient peoples used pyramids as tombs or temples. The most famous pyramids are those built about 4,500 years ago as tombs for Egyptian kings. These Egyptian pyramids are among the Seven Wonders of the Ancient World.

Egyptian pyramids

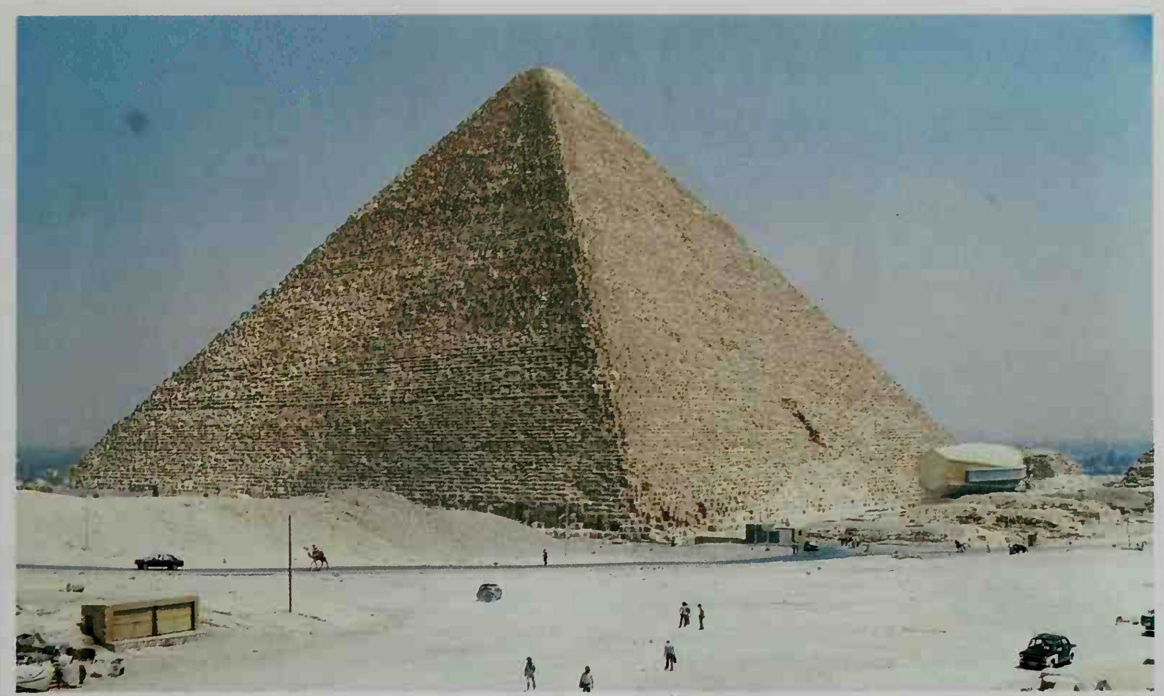
The ruins of 35 major pyramids still stand near the Nile River in Egypt. Each was built to protect the body of an Egyptian king. The Egyptians thought that a person's body had to be preserved and protected so the soul could live forever. The Egyptians *mummified* (embalmed and dried) their dead and hid the mummies in large tombs. From about 2700 to 1700 B.C., the bodies of Egyptian kings were buried inside or beneath a pyramid in a secret chamber that was filled with treasures of gold and precious objects.

Many scholars believe that the pyramid shape has a religious meaning to the Egyptians. The sloping sides may have reminded the Egyptians of the slanting rays of the sun, by which the soul of the king could climb to the sky and join the gods.

Funeral ceremonies were performed in temples that were attached to the pyramids. Most pyramids had two temples that were connected by a long stone passageway. Sometimes a smaller pyramid for the body of the queen stood next to the king's pyramid. Egypt has at least 40 smaller pyramids that were used for queens or as memorial monuments for kings. The king's relatives and officials were buried in smaller rectangular tombs called *mastabas.* These buildings had sloping sides and flat roofs.

The first pyramids. Imhotep, a great architect and statesman, built the first known pyramid for King Zoser about 2650 B.C. Zoser's tomb rose in a series of giant steps, or terraces, and is called the *Step Pyramid.* This pyramid still stands at the site of the ancient city of Memphis, near Saqqarah.

The first smooth-sided pyramid was built about 2600 B.C. It still stands at Medum. It began as a stepped pyramid, and then the steps were filled in with casing stones to give the building smooth, sloping sides. Other pyramids built during a period of Egyptian history called the Old Kingdom (2686-2181 B.C.) can be seen at Abusir and Dahshur. During the Middle Kingdom (c. 1991-1786 B.C.), pyramids were built at Hawara, Illahun, Lisht, and Dahshur—near what is now Cairo. The remains of these pyramids are still impressive.



Artstreet

The Great Pyramid, built about 4,500 years ago, rises at Giza, near Cairo.

The Pyramids of Giza (Al Jizah) stand on the west bank of the Nile River outside Cairo. There are 10 pyramids at Giza, including three of the largest and best preserved of all Egyptian pyramids. They were built for kings about 2600 to 2500 B.C. The largest was built for King Khufu (called Cheops by the Greeks). The second was built for King Khafre (Chephren), and the third for King Menkaure (Mycerinus). A huge statue of a sphinx, called the Great Sphinx, was probably built for Khafre. It stands near his pyramid.

The pyramid of Khufu, called the *Great Pyramid,* contains more than 2 million stone blocks that average $2\frac{1}{2}$ short tons (2.3 metric tons) each. It was originally 481 feet (147 meters) tall, but some of its upper stones are gone now and it stands about 450 feet (140 meters) high. Its base covers about 13 acres (5 hectares).

A study of the Great Pyramid shows how these gigantic structures were built. The ancient Egyptians had no machinery or iron tools. They cut big limestone blocks with copper chisels and saws. Most of the stones came from quarries nearby. But some came from across the Nile River, and others came by boat from distant quarries. Gangs of men dragged the blocks to the pyramid site and pushed the first layer of stones into place. Then they built long ramps of earth and brick, and dragged the stones up the ramps to form the next layer. As they finished each layer, they raised and lengthened the ramps. Finally, they covered the pyramid with an outer coating of white casing stones. They laid these outer stones so exactly that from a distance the pyramid appeared to have been cut out of a single white stone. Most of the casing stones are gone now, but a few are still in place at the bottom of the Great Pyramid.

The burial chamber is inside the Great Pyramid. A corridor leads from an entrance on the north side to several rooms within the pyramid. One of the rooms is called the *Queen's Chamber,* although the queen is not buried there. The room was planned as the king's burial chamber. But Khufu changed the plan and built another burial chamber, called the *King's Chamber.* The *Grand Gallery,* a corridor 153 feet (47 meters) long and 28 feet (8.5 meters) high, leads to Khufu's chamber. It is considered a marvel of ancient architecture.

No one knows how long it took to build the Great Pyramid. The ancient Greek historian Herodotus said that the work went on in four-month shifts, with 100,000 workers in each shift. Scholars now doubt that account and believe that about 100,000 men worked on the pyramids for three or four months each year. Farm laborers built the pyramids. They worked on the tombs during periods when floodwaters of the Nile covered the fields and made farming impossible.

Thieves broke into most of the pyramids, stole the gold, and sometimes destroyed the bodies. Later Egyptian kings stopped using pyramids, and built secret tombs in cliffs. But some kings of the Kushite kingdom in Nubia, south of Egypt, built pyramids long after they were no longer used in Egypt.

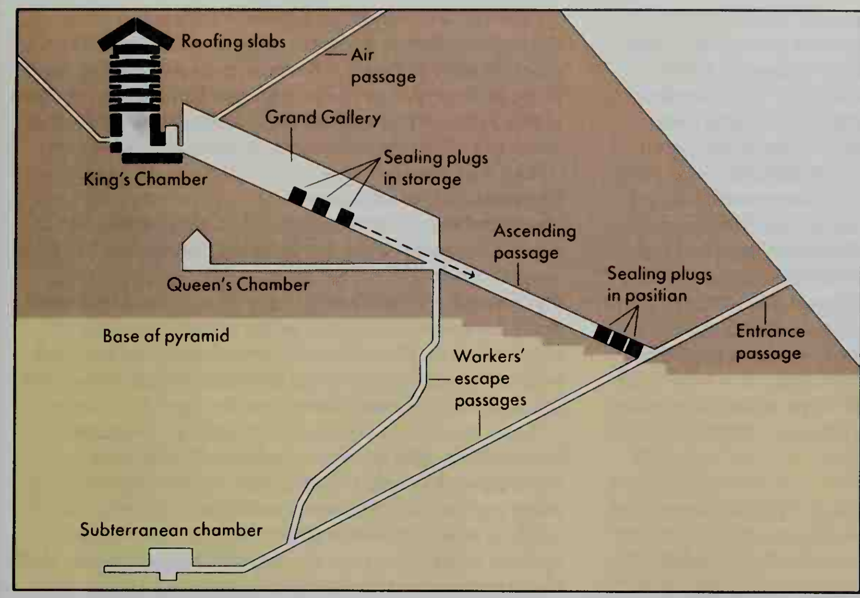
American pyramids

Indians of Central and South America also built pyramids. They built stepped pyramids that had flat tops. They used the flat tops as platforms for their temples.

The Moche Indians of Peru built large brick pyramids. *The Temple of the Sun,* near what is now Trujillo, on Peru's northern coast, has a terraced brick pyramid on top of a stepped platform. The ancient Mayas of Central America built pyramid-shaped mounds of earth

WORLD BOOK illustrations by Robert Addison

Building the pyramids was a great engineering feat requiring thousands of workers. First, workers cut and shaped huge limestone blocks using chisels and saws, *above.* Groups of workers dragged the blocks to the pyramid site on sledges and pulled them up ramps on the pyramid, *below.* Planks on the ramps lessened the friction of the sledges. As the pyramid grew taller, workers extended the ramps. Over 2 million blocks were used in building the Great Pyramid at Giza.



WORLD BOOK diagram

A cross section of the Great Pyramid shows the Grand Gallery, the King's Chamber, the Queen's Chamber, and various passages. After the burial, large blocks called sealing plugs were allowed to slide down the passageway from the Grand Gallery to seal off the tomb. Workers left the tomb through an escape passageway.

with temples on top (see **Maya** [pictures]).

Indians of central Mexico also built big stepped pyramids. For example, Indians constructed the great pyramids of the Sun and Moon that still stand at Teotihuacán, near Mexico City. The Toltec Indians built a stepped pyramid at Cholula that is one of the largest structures in the world. The Spanish conquerors destroyed most pyramids of the later Aztec Empire in Mexico. These pyramids were built in steps or terraces like the other American pyramids and had temples on top. Two of the greatest were at Tenochtitlan (now Mexico City). Mound-building Indians of North America built some pyramid-shaped mounds, but they were not true pyramids (see **Mound builders**). Leonard H. Lesko

See also **Egypt** (picture: Giant pyramids); **Egypt, Ancient** (pictures).

Additional resources

Level I

Martell, Hazel M. *The Great Pyramid.* Raintree Steck-Vaughn, 1998.



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The Pyramid of the Sun at Teotihuacán, Mexico, had a larger base than the largest pyramid in Egypt.

Mellett, Peter. *Pyramids.* Gareth Stevens, 1999.
Millard, Anne. *Pyramids.* Kingfisher Bks., 1996.

Level II

O'Neal, Michael. *Pyramids: Opposing Viewpoints.* Greenhaven, 1995.
Verner, Miroslav. *The Pyramids: The Mystery, Culture and Science of Egypt's Great Monuments.* Grove Pr., 2001.

Pyramus and Thisbe, *PIHR uh muhs, THIHZ bee,* are young lovers in an ancient legend. Pyramus and Thisbe lived next door to each other in Babylon. They fell in love, but their parents would not let them marry or even spend time with each other. They had to talk through a crack in the wall between their houses.

Finally, they planned to meet at night under a mulberry tree outside the city. Thisbe arrived first. She was frightened by a lioness that had bloody jaws from killing an animal. The frightened Thisbe ran away, dropping her veil as she fled. The lioness tore the veil apart with its bloody mouth. Pyramus then arrived and saw the tracks of the lioness and the blood on the veil. He thought Thisbe had been killed and stabbed himself in grief. Thisbe returned to the scene and found Pyramus dead. She then stabbed herself with his dagger.

The Roman poet Ovid told the story of Pyramus and Thisbe in his *Metamorphoses.* William Shakespeare's play *A Midsummer Night's Dream* includes an amateur theater group that performs a comic adaptation of the legend. Elaine Fantham

Pyrenees, *PIHR uh NEEZ,* is a mountain chain that forms a natural barrier between France and Spain. The mountains extend over a length of about 270 miles (435 kilometers), from the Bay of Biscay to the Mediterranean Sea (see **Spain** [terrain map]). They cover an area of over 20,000 square miles (52,000 square kilometers). Their average height is 3,500 feet (1,070 meters), but many peaks in the central ranges rise over 10,000 feet (3,000 meters). The highest point is Pico de Aneto (11,168 feet, or 3,404 meters).

Glacier fields are found on the northern slopes of the Pyrenees. Minerals in the Pyrenees include cobalt, iron,

lead, and silver. The iron mines near Bilbao, Spain, at the Biscay end of the Pyrenees, are a prosperous industry. There are forests of fir, oak, and pine on the mountains.

The Pyrenees chain is a barrier to overland commerce, and France and Spain had to trade with each other chiefly by sea for many years. Several roads now cut through the mountains. Two railways cross them. The first runs between Pau, France, and Saragossa, Spain, by way of the Canfranc Tunnel. The second runs between Toulouse, France, and Barcelona, Spain. This line climbs to a height of 5,200 feet (1,580 meters). There are more than 40 tunnels in a 57-mile (92-kilometer) central section of the Pyrenees. Several resorts are located on the northern slopes of the Pyrenees. The small country of Andorra lies on the south slope of the eastern Pyrenees. The Basques live in the western Pyrenees.

Hugh D. Clout

See also **Andorra; Basques.**

Pyrethrum, *py REE thruhm* or *py REHTH ruhm,* is the name of a group of flowers. Pyrethrums are also called *painted ladies* or *painted daisies.* The flower heads of pyrethrums grow singly or in clusters on erect stems that rise 1 foot (30 centimeters) or more. Pyrethrum flowers look like daisies with pink, white, crimson, or lilac rays. Pyrethrums bloom in spring or early summer, and they are grown as garden flowers or for cutting.

An insecticide is made from the dried and powdered flowers of two species of pyrethrums. This insecticide is also known as *pyrethrum.* In pure form or in a mixture, it is the least poisonous insecticide to animals and people. It is used in liquids, powders, and sprays for insect control on animals, in the garden, and in the home. Kenya is the world's largest exporter of the powder used in making pyrethrum insecticide.

A pyrethrum known as *feverfew* is used as a tonic. A sedative used to treat *neuralgia* (severe pain along a nerve), toothache, and headaches is also called *pyrethrum.* But it is made from the root of a different kind of plant.

Scientific classification. Pyrethrums belong to the composite family, Compositae. The insecticide is made from species with the scientific names *Chrysanthemum coccineum* and *C. cinerariifolium.* Feverfew is *C. parthenium.* The sedative comes from *Anacyclus pyrethrum.* Margaret R. Bolick

See also **Feverfew.**

Pyrite, *PY ryt,* or "fool's gold," as it is sometimes called, is a compound of iron and sulfur, FeS_2. Another name for it is iron pyrite. Pyrite is found in many places and is often mistaken for gold. It can be distinguished from gold by heating it. Real gold will not react when heated, but pyrite will smoke and produce a bad odor. Pyrite is used to make sulfuric acid. The name *pyrite* comes from the Greek word for fire.

When pyrite is struck with a hammer, sparks are produced. In the past, some Indians and members of a number of other cultures used pyrite in order to make fire. Kenneth J. De Nault

See also **Mineral** (picture: Common minerals with metallic luster); **Iron and Steel** (Kinds of iron ore).

Pyromania, *PY ruh MAY nee uh,* refers to an uncontrollable urge to set fires. A pyromaniac experiences tension or arousal prior to setting a fire, and relief or gratification when setting or witnessing a fire. Some pyromaniacs feel sexual excitement from setting a fire. Others experience a release of hostile feelings. Pyromaniacs do not set fires for financial gain or political reasons, or in response to delusions or hallucinations. Pyromania is much more common in males than in females. It usually begins in childhood. Allen Frances

See also **Arson.**

Pyrosis. See **Heartburn.**

Pyrotechnics, *PY ruh TEHK nihks,* is a term used to mean fireworks, or the art of making fireworks. See **Fireworks.**

Pyroxene, *PY rahk seen,* is any of a group of minerals that play an important part in the formation of many kinds of rocks. Pyroxenes occur widely in the continental and oceanic crusts of the earth, as well as in many of the rocks of the moon's outer crust.

Most pyroxenes are the direct product of igneous and metamorphic processes of rock formation (see **Rock** [Igneous rock; Metamorphic rock]). Geologists study pyroxenes that have crystallized from *magma* (molten rock material) and, by doing so, they have learned much about the changes undergone by rocks that have formed from magma.

Pyroxenes range in color from greenish black and reddish brown to colorless. All pyroxenes have the same *silicate structure.* In this structure, a silicon atom at the center with four oxygen atoms attached forms a *tetrahedron,* a pyramidlike figure with four triangular faces. These groups of atoms band together in a single chain, with two of the four oxygen atoms connecting to adjacent tetrahedra. The chains, in turn, are linked together by positively charged atoms called *cations* within the *unit cell* of a pyroxene (see **Mineral** [Inside minerals]).

Cations of different elements affect the arrangements of the chains within the crystal structures. With a calcium, sodium, or other large cation present, the crystals form a *monoclinic* pattern (see **Crystal**). These pyroxenes are called *clinopyroxenes.* With a small cation, such as iron or magnesium, the crystals form an *orthorhombic* pattern. These pyroxenes are called *orthopyroxenes.*

The most common varieties of clinopyroxenes are augites, diopsides, and pigeonites. The most common orthopyroxenes are bronzites and hypersthenes.

Robert W. Charles

See also **Basalt; Diopside; Silicate.**

Pyrrha. See **Deucalion.**

Pyrrhic victory. See **Pyrrhus.**

Pyrrho of Elis, *PIHR oh uhv EE luhs* (361?-270? B.C.), was the founder of Skepticism. Skepticism was a philosophical movement of ancient Greece. Pyrrho traveled widely and learned many different philosophic viewpoints, each one claiming to be the truth. Because not all viewpoints could be right, Pyrrho decided to suspend judgment about truth, right, and wrong. Custom and convention, he felt, were the only guides to what is just or unjust. Even our senses tell us only how things appear, not what they really are. Pyrrho was born at Elis, Greece. S. Marc Cohen

See also **Skepticism.**

Pyrrhotite. See **Mineral** (picture).

Pyrrhus, *PIHR uhs* (318?-272 B.C.), was a king of Epirus in Greece. His name has lived in the expression "Pyrrhic

victory." It is used to refer to a victory that has cost more than it is worth. The expression arose from a remark that Pyrrhus used after fighting the battle of Asculum in which he lost almost all his men. He exclaimed, "Another such victory and I shall be ruined."

Pyrrhus was a second cousin of Alexander the Great, the king of Macedonia. Pyrrhus was born in Epirus. His father was king of Epirus. However, he lost his throne and was killed when his son was 2 years old. Pyrrhus was put on the throne at the age of 12, but at 17 he lost it. Later Pyrrhus went to Egypt where he served King Ptolemy.

Pyrrhus raised an army and returned to his native country. He recovered his throne and then tried to conquer Macedonia. In 287 B.C., Pyrrhus became king of Macedonia. However, he lost his throne again the following year.

Tarentum, a Greek colony in lower Italy, and its neighbors appealed to Pyrrhus in 281 B.C. for aid against the Romans. Pyrrhus sent 25,000 men and 20 elephants. His forces conquered the Romans, chiefly because of the use of elephants in the battle.

Pyrrhus later helped the Greeks of Sicily against the Carthaginians. In this war, he was successful at first. But he soon began to lose, and finally he was driven out of Sicily in 276 B.C. Two years later, the Romans defeated him and forced him to return to Epirus. The next year, he invaded Macedonia again and once more was hailed as king. In 272 B.C., he marched south and made an unsuccessful attack on Sparta. He was killed in a battle with Antigonus Gonatus while trying to capture Argos.

Ronald P. Legon

Pythagoras, *pih THAG uhr uhs* (580?- ? B.C.), was a Greek philosopher and mathematician. Pythagoras was famous for formulating the *Pythagorean theorem,* but its principles were known earlier. The theorem states that the square of the hypotenuse of a right-angled triangle is equal to the sum of the squares of the other two sides.

As a philosopher, Pythagoras taught that number was the essence of all things. He mystically associated numbers with virtues, colors, and many other ideas. Pythagoras also taught that the human soul is immortal and that after death it moves into another living body, sometimes that of an animal. This idea is called *transmigration of the soul.* It appears in many early religions and is still the belief of many of the Hindu sects of India. Pythagoras may have obtained some of his ideas during travels in the East.

Pythagoras believed that the earth was spherical and that the sun, moon, and planets have movements of their own. His successors developed the idea that the earth revolved about a central fire. This belief anticipated the Copernican theory of the universe (see **Copernicus, Nicolaus**).

Little is known of Pythagoras' early life, but scholars believe that he was born on the island of Samos. In about 529 B.C., he settled in Crotona, Italy. Pythagoras founded a *school* (brotherhood) among the aristocrats of that city. The people of Crotona were suspicious of the Pythagorean brotherhood because its members were aristocrats. The people killed most of the members in a political uprising. Historians do not know whether Pythagoras left the city some time before the outbreak of violence and escaped death there, or was killed in it. The brotherhood of aristocrats was finally destroyed in the 400's B.C.

S. Marc Cohen

See also **Triangle; Pre-Socratic philosophy.**

Pythagorean theorem, *pih THAG uh REE uhn THEE uhr uhm,* in geometry, states that in a right triangle the square of the length of the hypotenuse equals the sum of the squares of the lengths of the other two sides. The *square* of a number is the number multiplied by itself. A *right triangle* is one in which one angle measures 90°. The *hypotenuse* is the side opposite the right angle. The Pythagorean theorem written as a formula is:

$$c^2 = a^2 + b^2$$

In this formula, c is the length of the hypotenuse, and a and b are the lengths of the other two sides. If you know the lengths of any two sides of a right triangle, you can find the length of the third side.

Origins. The ancient Egyptians wanted fields with square (90°) corners. They had few of the tools we have today. How could they make a 90° angle? About 2000 B.C., they discovered a "magic 3—4—5" triangle. Workmen knotted a loop of rope into 12 equal spaces. They stretched the rope around three stakes to form a triangle. They placed the stakes so the triangle had sides of 3, 4, and 5 units. The angle opposite the side of 5 units (the hypotenuse) measured 90°.

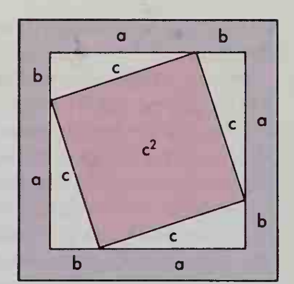
The ancient Babylonians noticed a special characteristic of the numbers of the 3—4—5 triangle. They saw that $3^2 + 4^2 = 5^2$ $(9 + 16 = 25)$. The Babylonians found other groups of three numbers that had this characteristic.

Between 500 and 350 B.C., a group of Greek philosophers called the Pythagoreans came to regard the sides of the 3—4—5 triangle as the sides of three squares. They knew that the area of any square is the length of a side multiplied by itself. Thus, they saw that the area of the square on the hypotenuse equals the sum of the areas of the squares on the other two sides. They also discovered that this relationship among squares is true for all right triangles. They stated this in the rule that became known as the Pythagorean theorem.

A proof. The Pythagorean theorem has had many geometric proofs, but no one knows which proof the Pythagoreans developed. Some mathematicians believe it was a *dissection* proof like the one described below.

In the drawing shown below, the two smaller sides (a and b) of a right triangle together equal the side of a large square. This square is divided into four right triangles, in which c is the hypotenuse, and two smaller, colored squares. The areas of the colored squares are a^2 and b^2. In the drawing on page 922, the triangles have been

rearranged so that their hypotenuses form the sides of a colored square. The area of the newly formed square is c^2. The area of both large squares is the same because each has a side equal to $a + b$. In the two large squares, the triangles occupy equal areas. Therefore, the colored portions of the two large squares occupy equal areas, and so $a^2 + b^2 = c^2$.



Mary Kay Corbitt

Pytheas, *PIHTH ee uhs,* was a Greek explorer who lived in the late 300's B.C. Pytheas slipped by a blockade set up by the Carthaginian navy at Gibraltar in order to explore the northern coasts of Europe. He sailed around Britain and explored that area. He heard of a mysterious land called Thule, which was probably Norway.

Pytheas was a great navigator. He knew that the North Star is not directly above the North Pole. He also realized that the moon has something to do with ocean tides. Many Greek authorities doubted his honesty. However, later discoveries showed that he was telling the truth about the things he had seen. Pytheas was born in Massalia (now Marseille, France). Ronald P. Legon

See also **Exploration** (The Greeks).

Pythias. See **Damon and Pythias.**

Python, *PY thahn,* is a large snake that lives in southeastern Asia, India, the East Indies, Africa, and Australia. Some pythons are among the world's largest snakes. The *reticulate python* of southeastern Asia and the East Indies and the *African rock python* may grow 30 feet (9 meters) long. Only the giant anaconda of South America rivals these pythons in length. The *amethystine python* of Australia and the East Indies and the *Indian python* of southeastern Asia and India grow about 20 feet (6 meters) long.

Pythons are called *constrictors* because they squeeze their prey to death. They wind themselves around the victim and tighten their coils. To kill their prey, they squeeze just hard enough to stop the victim's breathing and blood circulation. Large pythons usually eat small animals about the size of a house cat. But they may kill larger animals, such as wild pigs that weigh about 100 pounds (45 kilograms). Pythons swallow their prey whole. It may take a python many days to digest a large victim.

Pythons live in rugged tropical regions that have heavy rainfall and forests, or some type of low, dense growth. Almost all pythons swim and climb well.

Like most snakes, pythons hatch from eggs. The number of eggs in the nest varies greatly. Some may have about 100 eggs. The female python coils around her eggs until they hatch. The Indian python *incubates* her eggs, or keeps them warm with heat from her body. Incubation, which is very unusual in snakes, helps the eggs hatch more quickly. Albert F. Bennett

Scientific classification. Pythons make up the family Pythonidae. The reticulate python is *Python reticulatus.* The African rock python is *P. sebae,* the Indian, *P. molurus,* and the amethystine, *P. amethystinus.*

See also **Boa; Boa constrictor; Snake** (pictures).



J. H. Robinson, Animals Animals

The Indian python grows to about 20 feet (6 meters) in length.



